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THIRD AND FINAL REPORT

OF THE

GEOLOGICAL SURVEY OF NATAL AND ZULULAND.

BY

WILLIAM ANDERSON, F.R.S.E., F.G.S.,

(Corr. Mem. Scot. Geogr. Soc.).

GOVERNMENT GEOLOGIST.

Issued by direction of the Hon. C. J. Smythe, Premier and Colonial Secretary.

LONDON

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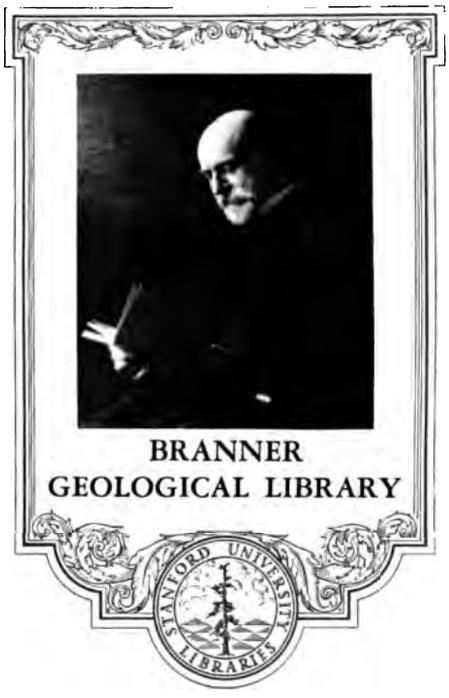
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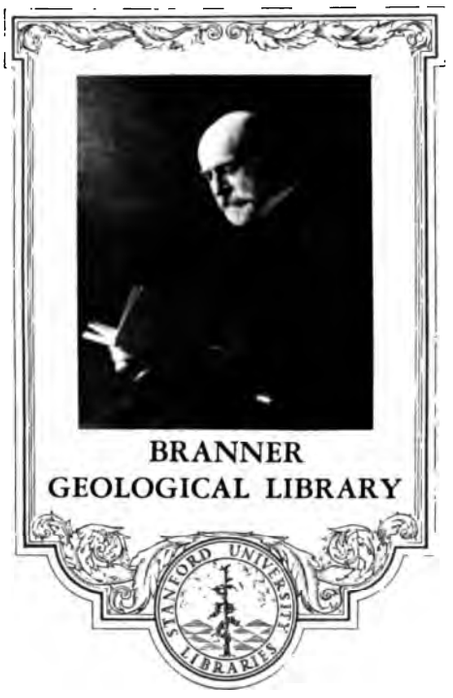
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LETTER OF TRANSMITTAL.

GEOLOGICAL SURVEY OF NATAL,
December 1, 1905.

SIR,

I have the honour to submit, herewith, the Third and Final Report of the Geological Survey of Natal and Zululand. Further contributions to the palæontology of the East Coast of Africa have kindly been furnished me by Mr. R. Etheridge, Jun., "On the Cretaceous Fossils of Natal" (Part II., "The Umsinene River Deposit"); and by Mr. G. C. Crick (Part III., "The Manuan Creek Deposit and the Deposit at the North End of False Bay"). I am also indebted to Professor W. B. Scott for his description of the "Mammalian Remains from the Tertiary Beds of the Coast of Zululand"; to Dr. R. Broom for his description of the "Reptilian Remains from the Beaufort Beds of the Umkomazan River, Natal," and "The Reptilian Remains from the Cretaceous Rocks at the Umpenyati River, Natal"; and to Dr. A. Smith Woodward for his description of the "Fish Remains from the Coal Measures of the Somkele Coal Field, Zululand, and from the Cretaceous Rocks at the Umpenyati River, Natal." I here take the opportunity of thanking these gentlemen for their kindness in undertaking the descriptions of the palæontological collections.

Very respectfully yours,
WILLIAM ANDERSON,
Government Geologist.

J. L. MASSON, Esq.,
Surveyor-General.

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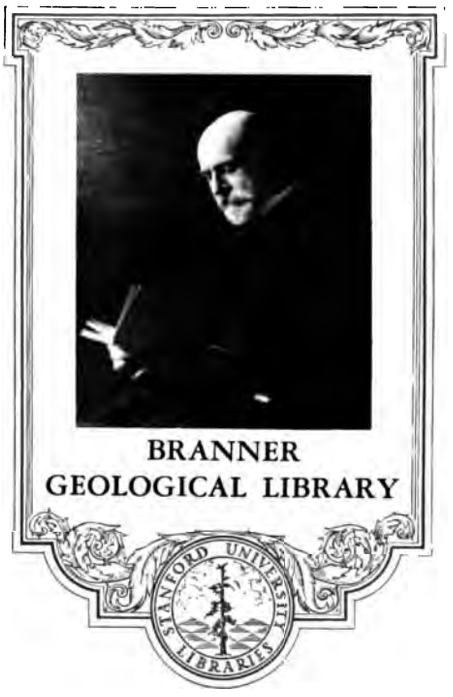
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J. W. Penny.

May 1909.

From September 19th to 22nd I visited the Bluff and inspected the core brought up from the bore for coal there.

On October 20th I left Pietermaritzburg for Bulwer, near which, on the Umkomazan River, I visited a series of Beaufort Beds containing Reptilian remains. From Bulwer I made a tour of the south-western part of the Colony, passing through Ixopo and Harding to Kokstad, and returning by Port Shepstone, arriving in Pietermaritzburg November 10th.

From November 18th to 21st I visited Congella in reference to the occurrence of a stiff clay deposit which was met with in dredging a passage at the upper end of the harbour.

From November 24th to 30th I visited the Frere and Chievely District for the Railway Department, to investigate the possibility of obtaining an artesian water supply for railway purposes at Frere.

From January 4th, 1905, to January 25th I was on annual leave.

From February 14th to 20th I went to Eshowe, to make arrangements for the transfer of my camp, &c., into Natal.

From March 15th to 20th I visited Port Shepstone to arrange about starting camp for the geological survey of Alfred County.

From March 23rd to 27th I visited the Impendhla District.

From April 5th to May 22nd I was in camp in the southern part of Alfred County.

From May 23rd to 29th I investigated occurrences of marine encrinital limestone in the neighbourhood of Mount Edgecombe.

From May 30th to June 23rd I was in camp in Alfred County.

From June 24th to July 10th I visited the Drakensberg Range from Ladysmith, by Bergville, Estcourt, Lutini River, Impendhla, and Dargle Road, for the purpose of writing a paper for the British Association Report.

From July 13th to 25th I was in camp in Alfred County.

From July 28th to August 7th I visited the Vryheid District to make arrangements for the geological excursion of members of the British Association to be led by Dr. Molengraaff and myself.

From August 17th to September 4th I took the geological members of the British Association from Durban to the Vryheid District and attended the meeting of the Association in Johannesburg, where I read a paper "On the Discovery of Marine Tertiary Rocks on the Coast of Zululand containing Mammalian Remains, &c."

From September 9th to 11th, and from September 28th to October 2nd, I accompanied geological members of the British Association to the South Coast.

On September 20th I handed in my resignation of the post of Government Geologist, and left the service on the 20th of December.

During the three years with which this Report deals no additions have been made to the staff, so that I have still been the only member of the Geological Survey. The offices have become much too small and the facilities for the necessary work have been at a minimum, so much so, that I found it impossible to carry on the Survey single-

handed, particularly as there seemed no chance of obtaining the necessary funds to insure the proper working of the Survey, owing to the financial depression in the Colony since the stoppage of the Boer War.

The Palæontological collections are gradually being described. Another portion of the Cretaceous fossils of Zululand has just come to hand from my friend Mr. R. Etheridge, of the Museum, Sydney, New South Wales (this forms the paper, p. 67). I have to thank Mr. Etheridge for his kindness in undertaking the description of these Cretaceous fossils, knowing well how busy he has been with his professional palæontological work for the Museum and Geological Survey of New South Wales. Other palæontological reports have been kindly furnished by Dr. A. Smith Woodward, Mr. G. C. Crick, Professor W. B. Scott, Dr. Broom, Mr. R. B. Newton, and Dr. Bather.

The library has increased in number of volumes to a very large extent, and the parts of nearly three hundred volumes have been put together and bound.

My lengthened absence from the Colony on Building Stones Commission work, and at home, necessarily restricted the amount of field-work done by me during the period with which this Report deals. It was of considerable advantage to me to have the opportunity, while on the Building Stones Commission, of travelling through such a large area of Cape Colony and the Orange River Colony. The comparison I was able to make between the developments and characteristics of the geological formations met with in these Colonies enabled me to obtain a better grasp of the relations and correlations of our Natal formations with those of Cape Colony and Orange River Colony; while the wider knowledge obtained helped to clear up many obscure points in the geology of Natal and Zululand.

Besides the lengthened periods in camp in Zululand and Alfred County, many trips of short duration were taken to various districts of the Colony, which were exceedingly useful in obtaining local knowledge, which is of great assistance in acquiring a more correct idea of the general geology of the Colony. The more important of these were: a journey through the south-western district of the Colony, which is described at p. 27; three visits to the Vryheid District, which are described at p. 11; and a visit to the Natal side of the Drakensberg Range, a description of which is given further on. A few of the minor journeys were profitless, such as that to Isipingo, where the reported discovery of coal proved to be the refuse of an old heap beside a ruined house. Another was the reported occurrence of a marine encrinital limestone in the neighbourhood of Mount Edgecombe. Some years ago Mr. Queckett, of the Durban Museum, called my attention to a few specimens of limestone containing the fossil remains of Encrinites, chiefly fragments of stems, which were reported to have been obtained near Mount Edgecombe, in the southern part of Victoria County. The rock was evidently of marine origin, and therefore an occurrence of this kind, in a district where all

the other rocks were of fresh-water origin, would have been of great geological interest. On investigation in the district, however, I found that specimens of the same encrinital limestone were frequently found associated with old bricks, where there had evidently been an old storage or other building; but as large quantities of imported lime have always been used in this Colony for the refining of sugar, I think, there is little doubt that these specimens had their origin as an imported foreign product. In fact, this conclusion is supported by my friend Mr. Keith Fraser, who informed me that it was quite a common occurrence to find among the imported lime hard lumps of limestone, which had to be thrown away, and these are probably the source of the specimens now referred to.

Some interesting specimens were sent me by Mr. Crofts, Harbour Engineer, Durban, which had been dredged from near the mouth of the Umzimkulu River, Port Shepstone. They proved to be specimens of an unmetamorphosed limestone showing indistinct but undoubted traces of plant remains, not unlike *Phyllotheca* stems. In this immediate neighbourhood the only Lower Karroo rocks developed are a portion of the Ecca Shales, overlying the glacial conglomerates, among which calcareous beds are not known. Unfortunately these few specimens were the only ones obtained, and as, from an examination of the district, no limestone was observed outcropping on the land, except the metamorphic rock which forms the marble of this district, there is no calcareous rock of Ecca age, and therefore this occurrence is the more remarkable.

Bluff Bore.

In the beginning of 1905 I had an opportunity of examining the core of the bore sunk at the Bluff, Durban, for coal. A description of the geology of this bore is given by me, and published in the Transactions of the Geological Society of South Africa of this year. Although the presence of Cretaceous rocks in the section shown by the bore was not expected by me when I wrote my Report on the prospects of obtaining payable coal under the Bluff in 1901, the mere fact of their presence, down to a depth of over 700 feet from the surface has greatly helped to support my contention that even without their presence the beds of the series overlying the Lower Eccas, which elsewhere contain our payable coals, could not possibly come in under the Bluff. The section exhibited in the core below the occurrence of the Cretaceous rocks fully bears out this idea. The intrusive diabase rocks are quite prominent as sills through this series of Lower Ecca Shales, and although the bore did not go so deep as to touch the Ecca Glacial Conglomerate (Dwyka), there is little doubt that the depth attained precludes the presence of the productive coal-measures.

Fossiliferous rocks, Zululand.

During the field seasons of 1903-04 I made a discovery of considerable palæontological interest on the coast of Zululand, namely, the occurrence of a series of marine strata of Tertiary age, overlying the Upper Cretaceous Series and containing, besides Mollusca, Foraminifera, Crustacea, large quantities of Mammalian remains, consisting chiefly of the fragmentary bones, teeth, &c., of elephant, rhinoceros, hippopotamus, &c. A description of these Mammalian remains forms

the Report further on by Professor W. B. Scott, of Princeton University, New Jersey, who has kindly undertaken to examine the collection.

The discovery of Reptilian bones in the Beaufort Beds of the valley of the Umkomazan River to the north of Bulwer, brought to my notice by my friend Dr. Lyster Jameson, who heard of their presence from Mr. Smith, schoolmaster at Bulwer, is also of importance from the fact that previously there are few recorded instances of the occurrence of Reptilian remains in Natal. Practically the only case is that mentioned by Dr. Sutherland, where Dr. Addison is reported to have discovered Reptilian remains near Weston, on the Mooi River, as far back as the fifties. Unfortunately the fossils from the Umkomazan River valley are very fragmentary, and are not at all well preserved. Dr. Broom has kindly described the more important and less fragmentary specimens at p. 93. Since the above discovery I have obtained identifiable fragments of undoubted Reptilian bones from the Lutini River valley, further to the north along the base hills of the Drakensberg Range. I have also seen fragments of fossil bone from still further north, in the neighbourhood of Giant's Castle.

During the field season of 1905 I had an opportunity of visiting the Cretaceous deposits of the south-east coast of Natal at the mouth of the Umpenyati River. Among the collection made the majority of the invertebrates have already been described by Baily and Griesbach. A number of Reptilian bones and the scutes of Chelonians were also obtained. These are noticed in Dr. Broom's Report on p. 93. The fish remains are described by Dr. A. Smith Woodward at p. 99, and a short description of the deposits is given at p. 50.

When the British Association visited Natal, a geological excursion was arranged to the Vryheid District, under the leadership of Dr. Molengraaff and myself. The selection of this district was made owing to the splendid examples of Permo-Carboniferous glacial geology which are exposed in the neighbourhood of the Ngotsche Mountain, where a magnificent series of striated surfaces and *roches moutonnées* are to be seen on the outcrops of the ~~Barberton~~ Beds, from the surface of which the Ecca Glacial Conglomerate (Dwyka) has been denuded. These surfaces were discovered in 1898 by Dr. Molengraaff when making a geological sketch map of the Vryheid District. The Glacial Conglomerate is here most typical in its development and characteristic in its structure, while the glaciated pavements below are, as far as we at present know, the best examples in South Africa. The grooving is exceedingly distinct, and frequently is of large calibre, and is plainly recognisable on the smoothed surfaces of the upturned Barberton slates. The much-disputed direction from which the ice travelled to produce these groovings is here distinctly apparent. In fact, on the *roches moutonnées* surfaces there are absolutely convincing proofs that the direction was generally from north to south. In other parts of Natal where glaciated pavements occur the evidence as to the

direction in which the ice moved was not of a convincing kind; but this conclusive evidence at the Ngotsche Mountain lends all that is necessary to the uncertain proofs of these localities.

The general geology of the Vryheid and Utrecht Districts is very simple, and is admirably described by Dr. G. A. F. Molengraaff in the Report of the Geological Survey of the South African Republic for 1898. In the upper reaches of the Pivaan River the old granites occur, while lower down this valley to its junction with the Pongola River, and down the latter river valley to the borders of Zululand, the ~~Barberton~~ Series of ~~slates~~ and quartzites, &c., is developed. In the southern portion of the district, in the valley of the White Umfolosi River, the granites occupy the higher portions of the valley, while the Barberton Series outcrops to the borders of Zululand near the Denny Dalton Mine. In the high country between these two river valleys and occupying the central portions of the district, these older rocks are overlain by the lower members of the Karroo system. Large areas are occupied by the Ecca Glacial Conglomerate (Dwyka), overlain by the Ecca Shales and probably in the upper portions of the hills by representatives of the Beaufort Series, although this has not yet been proved by palæontological evidence. These sedimentary rocks above the Glacial Ecca Conglomerate (Dwyka) are all practically horizontal, and this produces the flat-topped hills and mountains so characteristic of the scenery of the district. In some cases the preservation of these flat-topped mountains from denudation has been due to the presence of ~~diabase~~ sills which are extremely common as intrusions through the sedimentary strata. Among the sandstone series, seams of coal are of frequent occurrence, many of them of exceedingly good quality and in positions where they could be easily and economically worked. A coal-seam has been opened on a hill some miles to the south of Vryheid, from which the town has been supplied for some time. Another seam has been worked pretty extensively at the eastern end of Hlobane Mountain on the farm Hlobane. In this neighbourhood there are the outcrops of other coal-seams on horizons below the one which has been opened up. The transport of these coals is at present too expensive for them to be used outside the district, as it is said that Dundee coal can be trained into Vryheid town at a cheaper rate than the local coal can be produced and carted from the local mines. There is no doubt, however, that in time to come this district will prove itself to be a very important coal-producing area. There is a considerable extent of the district covered by the outcrops of diabase, whose intrusions have, no doubt, in places, had the effect of damaging the coal-seams, but this result will be of a purely local character. Many of the diabase sills are of considerable thickness, but it will only be in isolated cases where shafts will require to be sunk through these. Where the seams lie at a depth below the present valleys, sinking will have to be resorted to, and it is quite likely that diabase sills will be met with in the process, but not necessarily.

In the great majority of cases the coal-seams will be able to be worked by adit, and therefore shaft sinking will be rarely necessary. In the central portion of the district isolated outliers of granite outcrop through the Karroo Beds. They are usually of small extent, and are not of much importance from an economic point of view. In the larger areas of granite and the Barberton Series traces of the precious metal have been discovered in various localities—at Nondweni, the Denny Dalton, and at various places in the valley of the Pongola River and elsewhere; but so far no startling development has taken place in any of these localities.

Much of this non-development of mining properties in this Colony is due to the iniquitous mining law, which allows large areas of mining land to be locked up in the name of syndicates and private individuals, whose only idea is to sell on the development of a neighbouring property. They pay an absurdly small increment per annum for the privilege of shepherding their claims; that obnoxious method by which small revenue is derived, but which absolutely paralyses mining development, and which every mining country, Australia, America, &c., where mining and its laws are known, has abolished years ago.

During the field season of 1904 I took the opportunity of travelling through the plain-like littoral of Maputo or Amatongaland, lying between Northern Zululand and the Portuguese territory of Delagoa Bay. In extent it is on an average 50 miles wide from the Rhyolitic range of the Lebombo on the west to the sea coast.

The leading topographical features of this large area of littoral country may be summarised as a more or less level and undulating plain of deep sand superficially, usually grass-clad and covered locally by isolated patches of indigenous timbers and dense undergrowth. It is bounded on the west by the rugged, stony, and irregularly sculptured Lebombo Range, formed of an ancient Rhyolite, and on the east by the sand-dunes of the coast, which are frequently a distinctive feature in this littoral scenery, and often attain a height of over 500 feet. The Lebombo Range has an average height of between 1,800 and 2,200 feet, the latter point, some miles to the south of Ingwavuma Magistracy, being the highest point of the Range in Natal territory. A fine view of this Range may be obtained from the rising ground surrounding the Ungadu Pans, to the north of Lake Sibayi on the northern road to Foxon's Camp, where the outline of the Range forms the skyline to the west, presenting a fairly uniform altitude, except at the points where the various rivers have eroded a passage through it. From this point of view the valleys appear as if a series of wedges had been cut at intervals from the Range. The rivers passing through them on to the littoral, form what are locally known, from north to south, as the Ingwavuma, Pongola, Mkuzi, and Umsindusi Poorts. On the western side of the Range the general level of the country is much below that of the Range itself, and it seems a very peculiar circumstance that the rivers have been able to cut

through it to the level of the flat country on each side of the Range instead of taking a southerly course across the low country on the west side of the Range. The explanation, however, is not far to seek. The erosion of these poorts through the Range is not of yesterday. The beginning of their erosion must date to a period long anterior to the origin of the coastal plains as a land-surface. In fact, they must have formed the immediate openings of the rivers into the sea during the deposition of the Cretaceous rocks which now underlie the sands of the littoral, when the Rhyolitic Lebombo Range formed the coast-line of this part of the East Coast of Africa. In those times the rivers must have carried down most of the detritus obtained by the erosion of the country to the west of the Range, the levels of which then approximated to one another, which formed the material of which the conglomerates and other beds forming the Cretaceous formation now consist. The heavy fossiliferous conglomerates of the Upper Cretaceous Series are commonly met with along the eastern flank of the Range. They have formed the immediate coast deposits of this period. On the present coast-line, 50 miles away to the east from the Lebombo Range, the predominating beds are of later age, and consist of finer material, such as calcareous sandstones with sandy marls and clays, and occasionally thin conglomerates.

Over certain areas these plains differ considerably in their general aspects. From the base of the Lebombo Range for a long distance to the east the country is more or less covered with bush. Around Kosi Lake and Foxon's Camp or Magusa the country is distinctly hilly, although the hills do not attain any great height. This area is also very lightly timbered, except in the immediate vicinity of the creeks and the borders of the lake, where timber is abundant, but as a rule it forms open veld, almost entirely free from timber of any kind. This same characteristic obtains almost the entire distance to within some miles of the Enseleni River at the western end of Lake Sibayi, with the exception of a few isolated instances of not very extensive clumps of bush sometimes containing small timber. Such small areas of timber occur near some of the fresh-water pans, as at the Ungadu Pan. It is even rare north of the Enseleni River to find the palm which grows so plentifully to the south of the river, as this country presents to the eye merely a waving sea of grass. In the area south of the Enseleni River and Lake Sibayi, as far south as the Mkuzi River, the aspect of the whole plain is different. There are a few long low ridges over this area which can be noted as one travels over the plains, appearing now and again between the tree clumps. They are, however, usually free from timber, which occurs freely in isolated patches over large portions of this area, whose characteristic feature is that between the timbered areas it is dotted over with innumerable small patches of palm-trees. It is a curious fact that wherever pans of permanent water occur, which is rare, it is seldom or never the case that timber grows round them. An occasional patch of timber may be

present on one or other side of the pan, or on the rises at some little distance off, but they are never of any great extent.

Dotted over this immense area extensive forests of timber occur, containing quite a variety of large indigenous trees, many of which are of sufficient size and quality of timber to be of commercial value. At the present time this, as an industry, is not possible, because of the out-of-the-way country, which is difficult even of access, and where the difficulties of transport and the want of an immediate market are against any economic use being made of this timber. I have no doubt that in time these disabilities will be removed, but in the meantime it behoves the Government to have proper care taken of such important natural resources. It is no uncommon thing at the present moment in many parts of this area, wherever there is an accumulation of kraals, to find that the natives are cutting down and burning large quantities of this good, large timber, in order that when burnt it may furnish certain necessary chemical constituents to the sandy soil for profitable agricultural purposes. This principle is correct, in that a soil needs a certain amount of chemical compounds derived from the destruction and burning of vegetable matter; but it is a fatal policy to allow this indiscriminate destruction of timber by the irresponsible native. In this case the loss will be experienced by later generations, who will have had no voice in the care of these primitive forests, which should be a valuable asset to the country instead of being left as a perquisite to the native, who cannot appreciate the possibilities of the future. This is particularly the case wherever there happens to be a permanently running fresh-water creek which has eroded a small valley for itself. As a rule the sides of the valley are covered with timber of excellent growth, with much decaying vegetation below. Such a position is a typical one for the destruction of timber by the native, for increasing the productive capacity of the soil locally, on which to establish a mealie garden or sweet-potato patch. Many instances of this could be mentioned: the Enseleni River at the west end of Lake Sibayi, and the creek at Magusa or Foxon's Camp; but innumerable others could be given. In this way the country is gradually becoming depleted of its best indigenous timber, with little or no return of any national value to the country. In a sense, there is some slight excuse for this use of the timber in the country under discussion, because, as a rule, the generality of the soils are of a sandy nature and poor in quality. At the same time there are areas of fairly good soils which are not used by the natives, probably for the reason that in their neighbourhood there is no superficial water-supply to encourage them to form kraals close to these cultivable areas.

This great expanse of undulating plain country is, superficially, very poorly supplied with fresh water, which is usually quite local in its occurrence. This has necessitated the accumulation of native kraals in local areas, leaving large tracts, which grow splendid grass, entirely free from population. The few white people who have to live in this

inhospitable country—a couple of Natal Police, a storekeeper or two, with an occasional trader—only do so because good potable water is obtainable in the immediate vicinity of the habitat they have chosen for the location of their dwellings. From the Makowe Hills to the Portuguese border, a distance of nearly 80 miles, only two localities existed where there were white men; one was the store at the west end of Lake Sibayi (this has since been vacated owing to the death of the occupant) and the police camp at Foxon's Camp or Magusa, where there were two Natal Police (one of whom has since died) and a storekeeper. This does not include the store at Emtini, at the junction of the Ingwavuma and Pongola Rivers, close to the Lebombo Range and not far from the Portuguese border. In each of these cases the position of the habitation is in close proximity to a permanent running stream whose banks are thickly covered with timber and undergrowth, and fever is exceedingly prevalent and often proves fatal, even among the natives. There is no doubt that the prevalence of fever among the white population could be, if not entirely obviated, at any rate mitigated by a more careful attention to health, and particularly to the improvement in the quality of the food used, which is generally very inferior tinned stuffs.

Except in the cases of well-defined water channels, such as the short streams which enter the various lakes, and the well-marked river channels, such as that of the Pongola, Mkuzi, &c., the rolling character of the country does not lend itself to the superficial flowage of waters in any one direction for any lengthened distance. It is rare, therefore, to come across a desiccated waterway, but it is quite a common thing to meet with superficial hollows of all shapes and sizes which have evidently contained water during the rainy season, and often become filled after severe thunderstorms or local rains during the dry season. These pans in many instances are of a permanent character, and have never been known to dry up, and they frequently form the only source of local water-supply; but usually they are of a temporary character, and soon dry up under the influence of the sun and the rapid soakage into the sandy deposits below. In almost all cases these inland lakes and pans contain fresh water, which is usually potable unless the pan has become of very limited extent by desiccation. The water has, however, generally a peaty taste, from the large amount of decomposed vegetable matter which is present in it, and it always has a dark sherry colour for the same reason. At certain seasons of the year those of a permanent character are covered with large flocks of waterfowl of all kinds, which are as a rule extremely wild, and very difficult of approach. In the neighbourhood of these superficial waters, over the entire district, large numbers of guinea-fowl are of common occurrence, and can be easily shot towards sundown and at daybreak.

The present sources of water-supply over this plain-like area are as follows: The flowing streams, the pans, the fresh-water lakes, and the superficial sub-artesian wells. The flowing streams are quite infrequent. The larger and principal of these, after break-

ing through the Lebombo Range, flow eastward across the littoral. In all cases they do not flow directly into the sea, but first enter one or other of the numerous lakes or lagoons which are so prevalent along the littoral, behind the coastal sand-hills. All the smaller and local flowing streams either flow into the larger streams or into the lakes or lagoons.

The fresh-water lakes of any size are not numerous. In the case of Lake Sibayi, the water is fresh, and therefore forms an exceptional source of water-supply. It is the largest fresh-water lake and has no visible superficial outlet to the ocean. Many of the pans are of such extent when filled during the rainy season that they might then come under the appellation of small lakes, but they differ from the true lake, like Sibayi, in the fact, that during dry weather they contract often to mere mud-holes, while the lake only varies, in the driest weather, a few feet in its usual level.

In many localities the entire source of kraal water-supply is the superficial sub-artesian well, dug by the natives in the most primitive, irregular, and tortuous manner in the surface sands. They are usually so narrow that it is with difficulty an adult can descend to the water, which often, owing to the irregularity of the sides of the well, cannot be seen from the surface. In such circumstances it is an extremely difficult and arduous undertaking to water horses and cattle at these miniature wells, where the soakage is so slow that it even takes some time to get one bucket of water. In the localities where these wells are made use of, in the rainy season the superficial pans are usually sufficiently full to be employed as the chief source of the native water-supply, but in the winter months, which form the dry season, the native has to have recourse to the underground wells.

Large areas of this country are absolutely waterless superficially, and these are exceedingly hard upon cattle, as they are always covered with a depth of fine loose sand, through which it is extremely laborious trekking. In time to come, however, there is no doubt that good potable water will be obtained over much of these waterless areas by sinking into the Tertiary and Cretaceous strata below the superficial sands. The water obtained in this way may, in some instances, even be artesian in its character, particularly near the coast, for the Cretaceous strata outcrop along the eastern flank of the Lebombo Range, thus presenting a favourable intake for the soakage of superficial waters. As this westerly outcrop of the shore deposits of Cretaceous times forms the edge of a large basin of Cretaceous overlain by Tertiary beds nearer the coast, the larger portion of which is still under water, off the coast below the sea-floor of the Indian Ocean, it is an obvious geological fact that in the strata of these formations the soakage water from the area of intake must be stored up, and therefore can be made of utility by sinking or boring. At present we have little or no data on which to base a conclusion as to the probable thickness of the strata forming the Tertiary and Cretaceous formations of the littoral of Zululand, but I think there can be little doubt

that the thickness to the east must be considerable, and this would enhance the prospects of obtaining artesian water in the coastal area.

It is more than probable that another source of water-supply nearer the surface will be found over this large area; that is to say from a position below the Pleistocene and Recent sands, between them and the Cretaceous or Tertiary rocks, as the case may be. There is no doubt a considerable unconformity between the Pleistocene sands and the strata of the formation below, and it will be in the position of this unconformity that the above-mentioned water-supply will be obtained. There is ample geological proof that the upper surface of the Cretaceous and Tertiary strata is a most irregular one. For this reason a water-supply will not be obtained under every surface boring-point that is tried, but positions will be found where good water-supplies will be obtained, because there is every evidence to show that at this horizon between the Pleistocene sands and the older strata fresh water is circulating along the hollows and depressions on the unequal surfaces of the latter strata. Distinct evidences of this can be seen not only on the coast, but in many positions inland. Where the Cretaceous rocks have been exposed by denudation, there is usually to be found a strong-running spring of good fresh water flowing from beneath the Pleistocene sands, and very often forming the source of a present-day stream. The same thing is to be seen on the coast where these rocks are exposed in section: strong-flowing streams gush out on to the beach from the unconformity between the Pleistocene and Tertiary strata. The presence of such springs clearly shows not only that there is stored-up water among the rocks, but that it is in constant circulation, evidently with a more or less easterly trend towards the coast. It is obvious, therefore, that at many points to the west of the coast, on the littoral, such underground streams are quite likely to be tapped by bore from the surface and may prove artesian. In any case, there is every proof to show that good well-water can be obtained at no great depth from the surface over the larger portion of this extensive but poorly watered area, while by sinking deeper into the Cretaceous and Tertiary strata there is no doubt whatever that large supplies of well-water at least will be obtained, quite sufficient even for the irrigation of small local areas.

Apropos of these large uncultivated areas in Zululand and Natal and the negligent, fatuous methods of farming everywhere, I quote the following from a recent publication on scientific farming: "In a few years crop failures in America will be com-" "paratively unknown. This opinion was given by Mr. Wilson," "Secretary of Agriculture at Washington, who says that scientific" "methods of farming are grappling successfully with almost every" "difficulty. Experts have studied the conditions to such advantage" "that even deserts will be compelled to yield a harvest, and he" "predicted that within ten years the acreage yield of the United" "States would be literally doubled. This increase would be due" "entirely to the advance in the *farmer's* education."

This country abounds with game of all kinds, particularly in the area immediately to the eastern base of the Lebombo Range, although it is nothing uncommon to come across herds of wildebeest, buffalo, &c., well out on the plains towards the coast. Associated with these herds of large game are usually to be found the lion and other carnivora, such as the hyæna and native dog, the last of which hunts in packs and effectually clears the game out of the neighbourhood in which they are, while the former are usually accompanied by members of their own species. Small troops of lions of six or eight are frequently met with in the vicinity of the Lebombo Range. In fact, of late years they have become a distinct nuisance to the few white people who have to live in this area, and also to the unfortunate traveller who has to traverse this country. They are really effectually preserved by the fact, that they take refuge in the game reserves, where hunters are not allowed to follow them for the purpose of shooting them.

Kosi Bay is situated some miles to the south of the Portuguese border, in Tongaland. From its point of exit on the coast it extends for about 12 or 14 miles to the south, occupying the flat country immediately to the west of the coastal range of sand-dunes, which in this neighbourhood attain a height of some hundreds of feet. The outline of this lake as shown on our existing maps is not at all accurate, while its extent is much exaggerated. The lake—at least the northern portion of it—is tidal. The sea entrance is a winding channel of no great width, which leaves the upper or northern end of the lake and passes by an irregular valley which has been eroded through the sand-hills to the sea, for a distance of about a quarter of a mile. The northern end of the lake is quite shallow, but some distance to the south is contracted to a channel which connects it with the more extensive and southern portion of the lake. The deeper portions are towards its southern end, which, however, has no visible opening to the sea, as it is separated therefrom by a series of sand-hills. The western shores are distinctly hilly, like the country between the lake and Foxon's Camp. The sand-hill occurring immediately to the south of the sea opening is the highest visible hill along the coast to the north or south, as far as one can see from any one point of view which includes this sand-hill. At its base, both on the south side of the channel, where the latter leaves the lake and on the sea-shore outside, rocks are exposed from below the sands of the hill. They consist of calcareous sandstone, rather coarse-grained, but bearing a resemblance to those which occur in many positions along the coast to the south, and which probably belong to the Tertiary period. The specimens of this rock which I have examined contained no fossils, although I had not an opportunity of examining all the outcrops. When approaching the shallow northern end of the lake from a distance, its surface exhibits, at first sight, a curious reticulated appearance, which on closer examination resolves itself into irregularly curved lines of wattle-work, which have been erected

by the natives of the neighbourhood as "fish kraals," for the capture of fish, which are very abundant at certain times in this part of the lake. The principle of these "fish kraals," as they are locally called, is much the same as that which is involved in the net structures used for the capture of salmon on the coasts of the British Isles. The method of construction in Kosi Bay is certainly most primitive, but the result, as regards capture of fish, is equally successful, and owing to the shallowness of the water the structures are admirably adapted for the purpose, while the labour involved in securing the fish is practically nil. By the closing of the gateways to the labyrinthine passages the wattle-enclosed areas become natural aquaria for the storage of the live fish, as this part of the lake never gets altogether dry even at low tide. The tidal rise of the waters of the lake here is not great, being not more than a couple of feet or so even at spring tides. A feature of the shore of the north end of the lake is the presence at the highest tide mark, just at the edge of the grass, of a deposit forming a thick band consisting almost entirely of very small, well-rounded and eroded fragments of pumice, together with a few small Gasteropods. The beach of the lake is naturally sandy, but in the reaches and creek-coves the bed entirely consists of a black mud, over which innumerable large Gasteropods are continually moving.

The channel of exit forms a deep and very strong current, except for a short period during high water. When I visited Kosi Bay (July 28th), one could not cross it without swimming one's horse even at low tide, because of the depth and rapidity of outflow of the outgoing stream. Above the point at which the channel leaves the lake to enter the passage through the sand-dunes, a crossing may be effected in three or four feet of water among the "fish kraals," although most of the way across, which is circuitous, the depth is not more than a foot or so. It is reported that during high tides it is no uncommon thing for the boats of the British men-of-war, which sometimes visit this part of the Zululand coast, to pass up this channel into the northern end of the lake, but this could only occur for a very short period during each tide. This part of the lake is connected with the southern deeper portion by a tortuous channel which passes through the narrow neck between the two portions of the lake. The actual depths of the intervening channel and the southern part are not accurately known, as no soundings have been taken, so far as my knowledge goes. It is therefore impossible, at present, to gauge the area of deep water or the capacity or possibilities of this lake for economic purposes. From a superficial view of the lake it would seem as if it were against probability that a channel capable of being dredged could be kept open between the exit channel at the north end and the deep southern portion of the lake. With regard to the exit itself, it would, to my mind, be an extremely difficult and expensive matter to convert it into a possible sea opening for the passage of vessels into the lake. It opens on the sea-shore

into an open roadstead on a perfectly straight coast-line, and although rocks occur, even above high-water mark, on the south side of its entrance into the sea, the possibilities of building a permanent breakwater which would be of utility are of the most remote. The other method which has been mooted of converting the deeper southern end of the lake into a harbour, is the cutting of a completely new channel from the southern end, eastward through the sand-hills, direct to the ocean. In this case the same difficulty would arise as regards the feasibility of being able to build a permanent breakwater on this unprotected coast-line. As many of the sand-hills are some hundreds of feet in height, the arduous labour of forming a passage-way through them, together with the enormous expense this work would entail, puts this scheme beyond the reach of local finance for a long time to come.

Natal, Zululand, and the Vryheid District are exceedingly fortunate in possessing large quantities of good building stone. Although, in the three divisions of the Colony, the areas which contain good stone are more or less local, there is every facility for the introduction of railways or other methods of transport in these districts for the conveyance of the building stone to the various centres where they are required for building purposes. Notwithstanding the fact of the large amount of good building stone available, it is deplorable that, up to the present, some of the chief buildings, many of them of a national character, which should have been built, once for all, of the best building stone available in the Colony, have been erected of stone which would not even have graced a cowshed. To take one instance only, any one who takes the trouble to observe the comparatively recently built Upper House in Longmarket Street, Pietermaritzburg, will see at once that the blotched and discoloured front of the building has been entirely due to the use of a decidedly bad building stone and the careless selection of blocks irrespective of their grain or colour. Blemishes of this kind should never occur in a national building, such as the Upper House, particularly in a Colony like Natal, where there is such a large supply of good building stones. One could understand it if this stone were the best that Natal could produce. Another glaring fault is frequently apparent in many prominent buildings: the fact that when a good building stone is used in their construction two factors, which are easily remedied, usually come in to destroy the appearance of the entire building. The one is the result of bad quarrying, and the other is either the want of knowledge or carelessness in the selection of the blocks of stone for the facings of the buildings. In the first case, quarrying, like everything else, requires a skilled knowledge, which is absolutely essential to the production of blocks which will be suitable for the cutting and carving into the various forms and pieces which are required for the building. If this were more attended to locally, a great deal of useless expense would be saved in the condemnation of blocks which have been quarried in such a

way that they contain flaws and blemishes which no man with the necessary knowledge would allow to be put into a building. This, to my mind, is the chief cause, granted we are dealing with a good building stone, of the desperately bad fronts of our buildings, the cracked lintels and sills, and the gaping of the decomposed laminæ, which should never have been quarried in the centre of a block of stone. Another point in reference to quarrying, which, however, will probably remedy itself in time, is the fact that, in almost every case where quarrying is being carried on, the stone that is being quarried is the outcrop stone of the bed. Now, it is a well-known fact that all outcrops of rock, particularly a porous rock like sandstone, have undergone decomposition for a varying but usually considerable distance from the surface. This, unfortunately, is the class of stone which is now being put into our buildings, and this being so, it behoves the person who selects the blocks to be much more careful in his selection. As yet no quarries have been opened to any depth, and we have not tapped the better class of our building stones. This inferior outcrop-stone is to be seen in many of our railway and road bridges, where the nearest outcrop of rock with any pretence to solidity has been taken for building purposes. This, however, is not entirely confined to Natal, as in every part of South Africa in which I have travelled the same fault has been perpetrated, but in many cases it has been excusable, in districts where no good building stone was procurable, and which embrace very large areas in some parts of Cape Colony.

Just before I left the Colony I was called upon to inquire as to the suitability of the stone then being supplied from the Greytown District for the building of the new Durban Town Hall. This was entirely a case in point. The stone, when properly selected, will make an admirable building stone, but in the quarrying there has been an utter disregard of the first principles of its methods, in that many large blocks of great length, and otherwise of capital stone, have been cut with a continuous layer passing through them, very often within a few inches of one edge and sometimes right through the middle of the block. Many of these laminæ are of such a character that within a very short time, in a climate like Durban, where the stone will be exposed to a salt atmosphere and rapidly alternating heat and rain, their decomposition will produce a decided lifting of the stone, probably together with ugly staining. The remedy is to be found in the proper quarrying of the stone and the careful selection of blocks which are without flaws, and which would be suitable to withstand disfiguration from atmospheric decomposition.

With regard to the careless selection of the individual stones which are to be associated together in the face of a building, it is, I am sorry to say, only a too glaring fault to see, in most of our buildings, stones of all textures put together in a most heterogeneous way, as if the first stone that came to hand was put into the first place it would fit. To have blocks of coarse grit, often containing

recognisable pebbles, built in among a lot of fine-grained stones, not only offends the eye, but appears exceedingly slipshod, and often causes a weakness in the building, because coarse-grained sandstones are often more easily decomposed than fine-grained. Another fault is to be found with the indiscriminate way in which differently coloured stones are used in many buildings when there is really no necessity for it, except that the proper selection would entail a little more trouble. It is all very well to have two differently coloured stones in a building, such as are now being used in the new Post Office at Pietermaritzburg, where the lower storey is built of a distinctly bluish-tinted stone, while the superstructure consists of a light-grey coloured stone, both good stones for building purposes. In this case it is admissible, particularly for the reason that, since the exposure of the stones to the weather for nearly two years, the bluish stone of the base has become lighter and toned down considerably, while the light-grey stone above has become darker, so that they now present a nearer approach to each other in colour and blend nicely; the heavier-looking stone at the base and the lighter one above give the building a much more solid look. In the other case it is very reprehensible to give the front of a building a kaleidoscopic appearance by the indiscriminate use of individual stones of different colours and textures.

The rocks from among which durable building stones of good quality are to be obtained in this Colony are necessarily similar to those of other countries, but here we have less variety than elsewhere. This is due to the fact that our sedimentary formations outcrop individually over such large areas of the Colony, that there is a great similarity between the rocks of which they are composed, and there are no limestones among them. Among our plutonic and igneous rocks there is also little variety, as they chiefly consist of granite and diabase. The principal rocks are as follows:—Granites, quartzites, sandstones and grits, ~~diabase.~~ Dolerite

The granites are confined to the sub-coastal area of Natal from the Umtamvoona River mouth, by Inchanga to the Tugela River valley, as far up as its junction with the Buffalo River; the Nkandhla District and the Engoye Range in Zululand, and the valleys of the sources of the Umfolosi and Pivaan Rivers in the Vryheid District. In these various localities the granite differs much in composition, texture, and colour, and in only a few positions has it been used for building purposes. As a rule it is grey and porphyritic, but often various shades of pink and red. A good example of the grey porphyritic granite can be seen in the neighbourhood of Inchanga, while in the Umzinto District of Alexandra County a red-coloured granite occurs. This latter has been lately quarried on the coast, a few miles south of Alexandra Junction, and some of it has been used for building purposes in Durban. It is a moderately grained rock, but has large segregation patches, chiefly of hornblende and mica, which are very disfiguring, but which can quite easily be avoided, as they only occur sparingly

through the rock. Most of the solid parts of these granites would make admirable building stone, while many of them would take a good polish for ornamental work. One has only to observe the numerous buildings that have lately been built in Cape Town of the porphyritic grey granite of Table Mountain to see that even roughly dressed it makes a capital building stone, and gives a look of solidity to the building which an ordinary sandstone cannot impart.

Quartzites are not of much importance as building stones, because they occur but rarely in the Colony. They are present in the western part of Zululand, where they occupy a very limited area. They also occur in the Vryheid District, but in that portion of Natal there is abundance of sandstone of much better quality, which would be used in preference.

Sandstones and grits occur more widely distributed over the three divisions of the Colony than any of the other rocks. They are confined to the various divisions of the Karroo system from the Ecca Series, through the Beaufort Beds and the Stormberg Series to the Cave Sandstones at the top of the system; and also to the Silurian Table Mountain Sandstones. Large areas of both Natal proper and Zululand are occupied by the last-mentioned formation in the sub-coastal region of Natal, the greater part of Southern Zululand, and the Eshowe, Melmoth, and Hlabisa Districts. These sandstones and grits of the Table Mountain Sandstones do not make first-class building stones. They are usually thin-bedded and show much false bedding, and split in all directions after a very short period of weathering. As a local makeshift for better stone they do fairly well, and are, in fact, largely used in many localities where no better stone is available without heavy transport. In some cases where the beds are developed to a great thickness the stone is more compact and of a better quality, but this is not at all common. The conglomerates and pebbly grits of this formation are useless for building purposes.

By far the larger proportion of good building stone is derived from the sandstones and grits of the Karroo system, the outcrop of the older members of which, the Ecca Series and the Beaufort Beds, cover much more than half of each of the three divisions of the Colony. Of the younger members of the Karroo system, the Cave Sandstones are only represented in Natal by the outcrops which occur on the top of the Drakensberg, in a position in which their use as building stone is prohibitive; while much the same may be said of the sandstones of the Stormberg Series, which outcrop chiefly on the slopes of the Drakensberg, and are therefore tabooed as a practical source of building stone. There are, however, localities in various districts immediately to the east of the base of the Drakensberg where the isolated hills are still capped by sandstones of Stormberg age. An instance of this is the Magwaqua Range, immediately to the west and north-west of Bulwer, where the Stormberg Sandstones occupy the higher portions of the Range

as an outlier. In no other part of the interior of Natal proper, Zululand, or the Vryheid District, do we get rocks higher than the Beaufort Beds, so that none of the Upper members of the Karroo system are represented in the lower country to the east and north-east of the Drakensberg. The chief sources of building stones of good quality, such as sandstones, are from the Ecca Series and the Beaufort Beds. These two divisions of the Karroo system cover the western part of Natal proper from the base of the Drakensberg eastward to the Buffalo River. Further south its eastern boundary can be defined roughly by a line drawn from the junction of the Buffalo River with the Tugela, passing to the east of Greytown, Pietermaritzburg, Richmond, Ixopo, and Harding. A narrow belt extends along the coast from the mouth of the Umhlatuzi River in Zululand, past the mouth of the Tugela River, through Victoria County to Durban, and at intervals as far as Port Shepstone. This coastal outcrop is separated from that of the interior by the presence, at the surface, of the Table Mountain Sandstones, the granites and metamorphic rocks, from the Umtamvoona River mouth to the Tugela River. In the Vryheid District the higher portions of the country between the Buffalo River and the Zululand boundary are occupied by these formations, including the Ecca Glacial Conglomerate (Dwyka). In Zululand, a very large area of the interior consists of the outcrop of the Ecca and Beaufort Series, extending from the Vryheid border to the Somkele Coal-field, some miles below the junction of the Black and White Umfolosi Rivers, and from the Swaziland border in the Nongoma District to the basin of the Umhlatuzi River north of Eshowe.

The lower members of the Ecca Series, the Glacial Conglomerate (Dwyka) and the glacial Ecca Shales, are individually of no use as building stones, as in neither case do they contain beds of sandstone or grit, so that, over the areas enumerated large portions of Lower Eccas have to be eliminated as regards the procuring of building stones of good quality. This, however, leaves very large areas of coal-bearing sandstones in each of the three divisions of Natal. From this series the best of our building stones of sedimentary origin are obtained. It does not, however, follow that every sandstone occurring among these rocks is necessarily a first-class building stone, and in many cases even different parts of the same bed of sandstone may vary much in quality. In many portions of these sandstone areas the presence of intrusive diabase has practically obliterated the sandstones, as in the neighbourhood of Ladysmith and in the Impendhla District, where the sedimentary rocks are at a minimum, and therefore good sedimentary building stone is exceedingly rare. All over the northern coal-field, in the Dundee, Newcastle, and Vryheid Districts, sandstones of good quality adaptable for building purposes are of common occurrence. In the large area occupied by these rocks in Zululand no stone buildings of any

consequence have yet been built. Many of the isolated stores and the magistracies have been built of stone, but this has been taken from the nearest outcrop, without respect to its quality or durability.

In Natal proper many building stones of good quality and durability are already known from various districts. For instance, the stone from Alcock Spruit in the Newcastle District, that from the Town Hill, Pietermaritzburg, from the quarries in the neighbourhood of Greytown, and from those occurring on the north coast railway, the chief being at La Mercie, where a good but coarse-grained stone has been largely used even so far away as Durban, have all proved to be admirable for building purposes. The individual quarries mentioned above are by no means given here as a complete list of Natal quarries. As the demand for good building stones increases, the already opened quarries will be extended, and numbers of new quarries can easily be found in suitable positions as regards transport and working, and which would pay handsomely. There is no reason why, with proper quarrying and care in the selection of the individual stones, the public and principal buildings in the chief towns of Natal should not be, as far as the building stone is concerned, at least as good as in any other town in South Africa, and be a standing advertisement of the capital quality of the building stones of Natal.

The diabase rocks are widely distributed in every portion of the Colony, and as they occur chiefly in the form of horizontally intruded sills, and are much jointed, they are easily quarried. There is no question about the durability of this rock when the fresh, undecomposed portions are used for building purposes. It is a heavy, dark-blue coloured rock, which is admirably adapted for buildings or parts of buildings which require to be substantial. The finer-grained varieties are much better than the coarser and porphyritic varieties. It occurs of all degrees of texture, from partially differentiated glassy tachylites to exceedingly coarsely porphyritic rock. In different portions of the same sill many of these varieties occur. In many districts of the Colony it has been locally used in the building of residencies and court-houses, and is practically an indestructible stone from weather-wearing. Its colour is much against it as a building stone for general use, but where strong and substantial buildings are required it is perfectly suited for such permanent buildings as gaols, court-houses, &c. Its compactness and hardness make it a difficult stone to work, but when used only roughly dressed its appearance is quite good.

Of the other igneous rocks which are known from this part of South Africa, their utilisation as building stones can only be of a local character, and, at present, occurring as they do in out-of-the-way, unsettled districts, for all practical purposes they are useless. Besides the diabases there are few other igneous rocks, and they comprise the Rhyolite, of the Lebombo Range in the north of Zululand and the rocks of the Umqueme Range to the north-west of the Makowe Hills in North Zululand, the former

being volcanic and the latter of plutonic origin. In both of these cases the rock is not a particularly good building stone, and would only be used locally.

It seems hardly credible, but it is nevertheless a fact, that building stones in the form of Tertiary limestone from Oamaru, in the Middle Island of New Zealand, and Bath-stone and tile-stones from England, have been imported for building purposes, chiefly to Durban, for use in this Colony. Instead of importing building stones, there is really no reason why an export trade should not have been initiated long ago. When one takes into consideration the fact that the entire south-west of Cape Colony is destitute of a good sandstone building stone, and that every week there are numbers of steamers sailing from Durban to Cape Colony ports, often with very little cargo, it appears a remarkable thing that an export trade of this Natal product has not been started. Surely if the freight from New Zealand and from England allows of the introduction of building stones to Durban at a cheaper rate than a good local building stone can be sent by rail from within the Colony, it stands to reason that the freight, say between Durban and Cape Town, or even Port Elizabeth, cannot possibly kill a profit on a good building stone. Some years ago some of the prominent buildings in Cape Town (the South African Museum, &c.) were built of a Recent sandstone imported from Saldanha Bay on the West Coast, but this has since proved to be an exceedingly poor building stone. The granite of Table Mountain, which has been occasionally used, is too expensive for ordinary buildings. The base of the new Town Hall has been built of it, but the Bath-stone for the superstructure has been imported from England. This shows that in Cape Town, at any rate, there is an opening for the introduction, by cheap sea freight, of good building stones from Natal or elsewhere. It is true that in the north of Cape Colony and in the east, at Queenstown and other places, building stones of good quality occur, but at present the railway rates for these long distances are against their use except for local purposes, and besides, the double handling when shipping at the eastern ports would largely increase the expense of delivery at Cape Town. So that, taking everything into consideration, Natal seems to be the place for the export of building stones to those parts of South Africa which require them, and there is no doubt in my mind that this export trade needs only to be started to become not only a permanent but a lucrative one.

During a rapid journey from Pietermaritzburg through the south-western part of the Colony I have put together the following notes on the geological features met with. The portion of the Colony traversed embraces the districts of Impendhla and Dargle, Upper Umkomaas, Polela, Underberg, Ixopo, Harding, Kokstad, and Umzimkulu. The last-named district will, however, be included in the geological description of Alfred County at p. 105.

From Pietermaritzburg through the Zwart Kop location to Boston

the surface rocks consist of the Ecca Series, comprising shales and sandstones, with occasional intrusions of diabase in the form of both sills and dykes. The Edendale waterfalls, on the Umsindusi River, are caused by the presence of a diabase sill intruded among the shales and now exposed by the erosion of the river. At Boston the igneous rocks predominate, the sedimentary rocks being only represented by exceedingly limited patches of shales, &c., which are occasionally met with among the intrusive diabase. This particular mass of diabase is of very great extent as exposed on the present surface. Its limits are roughly as follows :—From Boston southward for some distance across the Umkomaas River near its junction with the Eland's River and up the Umkomaas to its junction with the Insinga River. It occupies the valley of the latter river, passes eastward, by Spion Kop, as far as Nottingham Road and its boundary passes east of Inhluzan Mountain, skirts Zwart Kop, and follows the upper part of the valley of the Eland's River to the neighbourhood of Boston. Over this large area of country the texture and composition of the diabase varies greatly, from a coarsely porphyritic structure to glassy tachylites. The differences in composition are largely due to the varying amount of felspar present and the absence or presence of olivine. This latter mineral is, as a rule, of rather rare occurrence in the diabases of the East Coast, but there is usually a large percentage of ferruginous material present in these rocks, in the form of magnetite, ilmenite, &c. The finer-grained diabasic anamesites and basalts form hard compact rocks, which do not easily weather, and for any substantial building which is required to stand for a long period this stone makes an admirable building stone. It is certainly difficult to work, but even when merely rough-hewn it is a solid and not at all a bad-looking stone, as the bluish-coloured surface takes a very long time to weather into the usual dirty yellow ferruginous oxidation. These diabases often contain a fairly large amount of iron pyrites, which is very prone to decompose rapidly, and thereby cause discoloration of the stone.

This very extensive intrusion of diabase seems to occur near the horizon of the passage from the Ecca Series to the Lower Beaufort Series. We have to the east of Boston sedimentary rocks of undoubted Ecca age, while below the diabase, in the Deepdale portion of the Umkomaas valley, Ecca Shales occur, and on the western side of this diabase outcrop, and overlying it, are the Beaufort Beds of the Bulwer neighbourhood, the Umkomazan and Lutini Rivers. In other parts of the Colony evidences of this also occur ; for instance, in the Vryheid District the bulk of the intrusive diabases occur about this horizon—in fact, the diabase sills cap most of the hills in those parts of the district where the coal-bearing series occurs. As the Ecca and Beaufort Series are conformable, and the presence of fossil remains is of rare occurrence, the division between the two series is at present quite an arbitrary one. In Cape Colony the presence of *Glossopteris* and the remains of certain reptiles are common to both, but in Natal we have rarely found *Glossopteris* or other plant remains associated with the remains of *Dicynodon* or other reptilian fossils. It is

true that our coals are always associated with a *Glossopteris* flora, which is a distinctive feature of the series of beds among which our coal-seams occur. So far we have had no local occurrences of reptilian remains from the coal-bearing series.

This diabasic area includes a very large portion of the Impendhla District, in which sedimentary rocks are of rare and isolated occurrence. One of the largest of these sedimentary outcrops occurs on both sides of the main road from Dargle to Impendhla, on the plateau immediately after rising the slope of the Inhluzan Mountain, coming from Dargle. In the road cutting going down to Impendhla they again appear as a small outcrop, and variously thus at occasional intervals over this diabasic area. The entire mass of the Inhluzan Mountain consists wholly of diabase except on the north-east face near the summit, where a patch of shales and sandstones, in section, appears wedged in between the diabase of the top of the mountain and the sill below. These sedimentary beds do not go right through the mountain, because the main western mass of the mountain consists of one of the most typical and fairly large diabase dykes which has come through the sedimentary rocks, the remains of which, left by denudation, appear near the summit of the mountain.

The diabasic plateau is cut through by the valley of the Umkomaas River, and its denuded edge is well seen when descending into the valley to Deepdale. In the road cutting on the left bank of the river the basaltic rocks become less in quantity and the sedimentary outcrops increase as we descend to the river at Deepdale, where the Ecca Shales are exposed. They have not here been eroded through so as to expose the Glacial Conglomerate, as has been done further down the river at the Umkomaas Bridge, on the road between Richmond and Ixopo. The western limit, therefore, of the exposure of the Glacial Conglomerate in the Umkomaas River valley occurs between these two points, Deepdale and the Umkomaas Bridge, and it is not seen again either to the west or north in this portion of Natal, as it is covered by newer formations which have not undergone sufficient denudation to expose it. Ascending the right slope of the Umkomaas valley from Deepdale, the Ecca Beds are exposed for a considerable distance towards Bulwer, but on reaching the plateau corresponding to the diabase of the left side of the valley, the variegated and highly-coloured shales of the Beaufort Series appear. From this point this Series outcrops very extensively to the south, west, and north. Southward it passes into the Ixopo Division, while to the westward its outcrop forms the country at Bulwer and Underberg, as far as the base hills of the Drakensberg. Northward it extends along the low country at the base of the Drakensberg in the upper reaches of the Mooi River, Bushman's River, and Tugela River, with a deflexion eastward down the valley of the Mooi River, as shown by the presence of Reptilian remains in the neighbourhood of Weston. Its eastern limit on the Tugela River occurs to the west of Bergville, for at the latter place the shales have all the well-known characters of the Ecca Shales, and contain remains of *Glossopteris* and *Phyllotheca*, but so far as my

examination went no Reptilian remains ; while, on the Lutini and Umkomazan Rivers many shale beds in this series are prolific in the fossil remains of Reptilia, but show no evidences of plant remains. In Cape Colony both the Beaufort and Ecca Series are reported to contain both Reptilian and plant remains of a similar character to those found in our Ecca Series. So far as our evidence goes there is no absolute line of division between these two series, as, to all appearance, they form a conformable series, so that if there is to be a workable division between the two, it will have to be palæontological. The occurrences of Reptilian remains have been so plentiful in the Beaufort Series of Cape Colony that an endeavour has been made to divide the series into groups according to the most common or typical reptilian remains found on each horizon. On the Natal side of the Drakensberg Range this is, as yet, impossible, as we have so little knowledge of the fossils of this series locally.

In the Bulwer District the rocks exposed at the surface belong to some part of the Beaufort Series. They outcrop at the present time, owing to the denudation of the newer portions of the Karroo System which have overlain them. Many of the isolated mountains in the district still retain a capping of some members of the Upper Karroo Series ; for instance, overlying the Beaufort Series which forms the base of the Magwaqua Mountain, immediately to the west of Bulwer, there is a considerable thickness of beds of Stormberg age, forming the summit of the mountain. These Stormberg Beds have yielded fossils such as *Thinnfeldia odontopteroides*, Morr., and *Pterophyllum*, &c., which are characteristic of this series. As is usual, the sedimentary rocks of this mountain are freely intruded by diabase. On the south-western face a number of exceedingly good examples of thin diabase dykes traverse vertically both the Beaufort and Stormberg Series, showing slight displacement of the strata. Lately Mr. Queckett has shown me specimens of fossil plants from this mountain. They have recently been presented to the Durban Museum, and are chiefly of the above-mentioned genera, and therefore belong to the Stormberg Series.

From Bulwer round the south of the Magwaqua Mountain the rocks passed over by either road to Underberg are Beaufort Beds, with a good deal of intrusive diabase. They occupy most of the country to the west, north, and south, as far as the base of the Drakensberg Range, and they form the base of all the isolated mountains which occur dotted over this country. To the north of Underberg a Government bore was sunk for coal, but the position in which it was put down shows that the rocks passed through belong to the Upper Beaufort Beds, not very far below the base of the Stormberg Series. Although coal is known to occur in the latter series it could not have been this series the bore was intended to strike, as the Stormberg Series is completely denuded away over this district except on the higher mountains. The few hundred feet which the bore was sunk penetrated the Upper Beaufort Series, in which coal has not yet been found in South Africa, while to reach the series of

rocks in which coal occurs in other parts of Natal, practically the whole of the Beaufort Series would have to be pierced. There is, however, no local evidence to show that, in this part of Natal, coal is present either in the Upper Eccas or in the Lower Beaufort Series, and therefore the bore was absolutely useless. The main portion of the slopes of the Drakensberg Range here consists of the outcrops of the Stormberg Series, which chiefly consists of sandstones with interbedded shales and occasional intrusions of diabase. So far no coal-seams have been opened in this series along the Drakensberg slopes. Evidences of the presence of coal are not, however, wanting, but the natural difficulties in the way of exploring and prospecting are great, while the expensive transport to populous centres is against the development of mines in this district, except perhaps for local consumption, which could not be very great.

Immediately to the east of the Drakensberg Range in the Bulwer and Impendhla Districts, the tributaries forming the sources of the Umkomaas River, which rise in the Drakensberg, have cut freely through the Beaufort Series, and many good sections can be obtained of these beds. In petrological characters they are entirely different from the shales forming the Ecca Series, but, like the Lower Ecca Series, they chiefly consist of shale beds. They are not nearly so friable nor so easily decomposed as the Eccas, but are, as a rule, much harder and more compact. Particularly is this the case in the beds among which the fossil Reptilian bones occur, where they are exceedingly hard, much-jointed, and brittle. In general character they are much more highly coloured, and bear a closer resemblance to the shales of the Stormberg Series than to those of the Eccas. The difference is due to the difference of the conditions under which they were formed, the Lower Ecca Shales having been deposited under sub-glacial conditions, while the Beaufort Beds are of purely lacustrine origin, not modified by glacial conditions.

There are few localities in Natal where the Beaufort Beds are known to contain the remains of Dicynodont and other Reptilian remains which are present so frequently in the Beaufort Series of Cape Colony. The only previously recorded instance is the occurrence, mentioned by Dr. Sutherland, of the Reptilian remains discovered by Dr. Addison near Weston, Mooi River, in 1854. These specimens were sent to Professor Sir Richard Owen, at the Royal College of Surgeons, London. Of the locality from which they were obtained Dr. Sutherland says:—"At Weston, on the Mooi River, above the" "wagon road, impressions of coal plants occur, associated with osseous" "remains of the Dicynodon and other saurians of the Mesozoic type." The plant remains were not, however, identified, and this is the only occurrence yet known in Natal of the association of plant remains with those of reptiles. Since then odd fragments of Reptilian bones, without a precise locality, have frequently come to light, but no accurate records of these have been kept. Reports have also reached me frequently, that large fossil bones had been seen in districts in which the Beaufort Series occurs, but in many cases they turned out to be

[illegible] trees [illegible] size. [illegible] a thin microscopic section the [illegible] are quite distinctly visible. As a [illegible] at right angles to their length, and it is [illegible] of large size of any length.

[illegible] of the Beaufort Series in the Bulwer District has proved [illegible] fragmentary fossil bones of reptiles. One locality [illegible] in the valley of the Umkomazan River, a tributary of the [illegible]. The position in which the bones occur most plentifully [illegible] above the junction of the two rivers. They are exposed on the [illegible] on the north side of the river, where there is a perpendicular [illegible] of shale, traversed by an intrusive diabase dyke. To the [illegible] of the Umkomazi, a little further up the river, the exposure of shales is much flatter, and it was on this outcrop that most of the specimens were obtained. The presence of fossil bones in this locality has been known to certain local residents for quite a number of years, but it was only lately, since sufficient scientific interest has been directed to them, that a more intimate knowledge of the beds has been obtained. This has been chiefly due to my friend Dr. Lyster Jameson, Professor of Biology in the Technical Institute, Johannesburg, who, in the prosecution of his professional duties, while visiting this district, heard of the presence of the fossils from Mr. Smith, the schoolmaster at Bulwer, who had, with some of his pupils, visited the spot and brought away specimens which were sufficient to identify the remains as Reptilian. It was through the kindness of Mr. Smith that Dr. Jameson and I were enabled to visit the locality, and the assistance of his pupils, who personally carried out the transport and camping arrangements, added greatly to the comfort and success of the visit.

The section [illegible] is composed, in the upper [illegible] of grey sandy shales below which is a thick series of bluish- [illegible] and among [illegible] the section is [illegible] a consider- [illegible] Underberg. [illegible] direction. [illegible] the [illegible] the [illegible] the [illegible] shales [illegible] the [illegible] the [illegible] the [illegible]

which has not been separated into two or more pieces by the jointing. The beds are practically horizontal, as they are over the whole district, except where they are locally tilted by the intrusive diabase. The concretions rarely contain as a kernel a bone or piece of a bone, and they are quite indiscriminately distributed through the beds, although occasionally they follow the bedding more or less regularly. The bones are extremely fragmentary, and altogether unsatisfactory for identification and description. One new species of *Lystrosaurus* is described by Dr. Broom, whose paper is on p. 93. He identifies the beds as comparable with the Middle Beauforts of Cape Colony.

From Bulwer to Highbury, and for some miles further to the east where the road descends the valley towards Ixopo, the Beaufort Beds persist, but in the descent we gradually pass on to the Ecca Series, which outcrops, with the usual intervention of diabase sills, all the way to the town of Ixopo and as far as the crossing of the Umzimkulu River at Hancock's hotel. On the rising ground between this river and its tributary, the Ibisi, a considerable thickness of Eccas comes in. In the valley of the latter river, where the bridge crosses beside the accommodation-house, denudation has cut through the Ecca Series completely, exposing the Glacial Conglomerate (Dwyka) in the river bed. The matrix here is fine-grained, and the boulders and pebbles of any size are very scarce, and even the smaller pebbles are not at all numerous. The outcrop only extends a few hundred yards above the bridge when it is covered by the Lower Eccas, fine-grained fissile shales, which are of a dark bluish colour. This is the furthest west outcrop of Ecca Glacial Conglomerate (Dwyka) in the Colony—that is, to the east of the Drakensberg Range. From this point on the Ibisi River it outcrops almost continuously in a south-easterly direction past Moguntia to the Umtamvoona River, and as far eastward as the Table Mountain Sandstone plateau which occupies the high ground in the eastern part of Alfred County. In the neighbourhood of the Ibisi and the Umzimkulu Rivers, after their junction, the Glacial Conglomerate rests immediately on the granite and metamorphic rocks, but further to the east it is underlain by the Table Mountain Sandstones.

From the Ibisi River to Harding, for some five miles on the road to Kokstad, the Lower Ecca Shales are exposed. From this onwards through the Ingeli Poort the whole country consists of diabase, which is evidently in the form of sills, as occasional small outcrops of shales, much indurated, occur among them. The main Ingeli Range is almost entirely composed of diabase. On the north-western side of the Range, facing Kokstad, the Ecca Shales are again seen in preponderance to the diabase. It is probable that the axis of the Ingeli Range is in the form of a diabase dyke of large proportions.

Associated with the sedimentary rocks, which have been highly altered by the intrusion of these diabase rocks, deposits of graphite occur on the eastern side of the Ingeli Range. These have been formed by the alteration of highly carbonaceous shales belonging to the Ecca Series. Such deposits are not at all uncommon in the Colony, where there are so many occurrences of intrusive rocks

which have penetrated the sedimentary strata containing carbonaceous shales or coal.

While carrying on the geological survey of Alfred County last field season, I was shown by Mr. Mitchell, at his store, a large number of beads, which he informed me the natives of the coastal districts had picked up at different times in the neighbourhood of the Inhlanhlinhlu Hill, which occupies a position between the mouths of the river of that name and the Boboi. They are said to occur among the sand and become exposed under certain conditions of the tides, &c., at the base of the hill, and, according to Mr. Mitchell, at some distance up the hill. Their occurrence is not only peculiar, but the beads themselves, being made of stone, are unique in South Africa. They consist of agates and jasperoid rocks, which, in some cases, approach carnelian. Their shapes are crystallographic, and they are pierced for stringing in a perfect way. The holes are quite cylindrical, and have undoubtedly been bored with an instrument used with a knowledge of boring. They are usually straight from one surface of the bead to the other, but some specimens show that the perforation has been started from both surfaces of the bead, and having met in the middle, produces a slight angle in the perforation. Their crystallographic shapes are not natural, but have been produced artificially, apparently by grinding by friction. Many different forms occur, the most common being in the form of a hexagon or octagon, often an inch in length, with a perfectly cylindrical hole bored through them parallel to their longer axis. Specimens of a double-truncated pyramid, four, six, and eight sided, are frequent, while others occur which do not now show the crystallographic form sufficiently clearly for identification. There is no doubt that in their manufacture the crystallographic idea was carried out, and that each bead was formed into the crystallographic shape to which it was previously conceived the fragment of rock was adaptable. In the condition in which they are at present found they show a considerable amount of abrasion, the crystalline edges and angles being often fractured and mostly rounded, as if by attrition.

Since ever beads took the place of cowries as a vehicle of exchange in Africa they have been, so far as our knowledge goes, made of glass. In no instance has there been a case where beads of stone are recorded as having been used by the natives for ornament or barter, and certainly no instance of their local manufacture by the natives is known. As against their local manufacture there is the absence of the necessary skill and knowledge of form and such accurate methods of drilling which the beads exhibit in their manufacture. Although most of the stone weapons which occur so plentifully in various localities over South Africa show a more or less definite form and exhibit a certain amount of culture in the tribes that made them, there is nothing so highly cultured as the fashioning of these beads into their crystallographic shapes and in possessing the capacity for boring the accurate cylindrical holes through the beads. Another objection to their local manufacture is the fact that no rocks in any way allied to the rock of which they are composed exists anywhere

nearer than the Tugela valley, the Vryheid border of Zululand, and in the Transvaal, and it seems extremely unlikely that the fragments of rock were transported from these localities to be fashioned into beads in Southern Natal. Agates occur frequently as amygdules in the lavas on the top of the Drakensberg Range. The only historical or legendary story which the natives possess in reference to the presence of the beads is the following: That, long before the white man came to the country, a great white form was seen on the sea, and on its disappearance the presence of quantities of these beads was recognised at the Inhlanhlinhlu Hill. Their occurrence is exceedingly interesting and curious, seeing that no other instance is known of the occurrence of stone beads in South Africa, but their source of origin is a mystery. It is more than probable that they are not of local origin, but as to where they came from and how they were brought to their present position it is so far impossible to hazard a conjecture.

I conclude this introduction by giving below a table showing the geological formations which I have found to be present in the three divisions of the Colony during the years of my geological investigations here.

			NATAL.	VRYHEID.	ZULULAND.
Recent and Pleistocene.			River and Lake Alluvials; Surface Iron-stone; Raised Beaches; Wind-blown Sands of Coast.	River and Lake Alluvials; Surface Iron-stone; Diatomaceous Earth.	River and Lake Alluvials; Surface Iron-stone; Diatomaceous Earth; Raised Beaches; Wind-blown Sands of Coast.
Tertiary.			Sandstones of the Bluff, Durban.		The Series of Beds forming the Coast.
Secondary.	Cretaceous.	Upper Cretaceous.	Umtamvoona Beds, South-east Coast, and in Bore, the Bluff, Durban.		Littoral of Zululand.
	Triassic.	Upper Karroo.	Plateau Basalts, top Drakensberg. Cave Sandstones, Drakensberg. Red Beds, Drakensberg. Stormberg Series, Drakensberg.		Rhyolitic Series of the Lebombo Range.
Palæozoic.	Permo-Carboniferous.	Lower Karroo.	Beaufort Beds.	Beaufort Beds.	Beaufort Beds.
			Ecca Series { Upper, Coal-bearing Series. Lower, Shales (glacial).	Ecca Series { Upper, Coal-bearing Series. Lower, Shales (glacial).	Ecca Series { Upper, Coal-bearing Series. Lower, Shales (glacial).
			Ecca Glacial Conglomerate (Dwyka).	Ecca Glacial Conglomerate (Dwyka).	Ecca Glacial Conglomerate (Dwyka).
	Silurian.		Table Mountain Sandstones.	Table Mountain Sandstones.	Table Mountain Sandstones.
		Lower Transvaal.		Hospital Hill Series.	Hospital Hill Series.
Archæan.			Swaziland Series. Intrusive Granite.	Swaziland Series. Intrusive Granite.	Swaziland Series. Intrusive Granite.

Intrusive Diabase, in all the formations up to the top of the Upper Karroo Series.

(The Horizontal Black Lines show Unconformities.)

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OF

NATAL AND ZULULAND GEOLOGY.

PART III.

BIBLIOGRAPHY OF NATAL AND ZULULAND GEOLOGY.

In continuation of the first and second parts of this Bibliography, published in the first two Reports of the Geological Survey, I publish the following additions to the list of papers, &c., dealing with the Geology of Natal and Zululand. I have to thank Mr. J. Ross, Librarian of the Natal Society's Library, for interesting himself in this matter and furnishing me with a number of references which are incorporated in this list. I have also to thank Mr. W. Rupert Jones, of the Library of the Geological Society of London, for his invariable kindness and assistance.

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THE

CRETACEOUS ROCKS

OF

NATAL AND ZULULAND.

PART I.—THE UPPER CRETACEOUS ROCKS OF NATAL AND ZULULAND.

It seems to me advisable to put together in this Report, which contains, further on, several important contributions to the palæontology of the Cretaceous deposits of Natal and Zululand, all the information with regard to these deposits which I have been able to obtain during the short existence of the Geological Survey. The previous allusions to the occurrences of Cretaceous rocks, in the already published volumes of the Geological Survey Reports, are to be found, in the First Report (1901), at pp. 19, 23, 43, 47, and in the Second Report (1904), at pp. 47 and 107; while a description of the Cretaceous Fossils of Natal, Part I., by Mr. R. Etheridge, is given at p. 71 of the latter volume. A casual mention of the occurrence of Cretaceous rocks in Natal is also made by Messrs. Rogers and Schwarz at p. 38 of the Annual Report of the Geological Commission, Cape of Good Hope, for 1901. Another recent allusion to Natal Cretaceous rocks occurs in the Monograph of the United States Geological Survey, vol. xliv., 1903, where Mr. A. Hyatt describes a new genus and species of *Pseudoceratites* from the Cretaceous of Natal, which he names *Eulophoceras natalense.* With these recent exceptions, there are few references to the Cretaceous rocks of this part of the East Coast of Africa. To the north of Delagoa Bay, however, the occurrence of Upper Cretaceous rocks has been recorded by Mr. R. B. Newton, in the district of Sofala, in 1896; while in 1900 Upper Cretaceous rocks were described from Mozambique by Mr. P. Choffat, and in German East Africa Bornhardt describes a series of fossils of Cretaceous age from that region. At the end of this paper a fairly complete list of authors who have referred to the Cretaceous rocks of Natal and Zululand is given.

The first mention of the occurrence of rocks of Cretaceous age in Natal and Zululand is made by Mr. C. L. Griesbach in 1870, in his paper "On the Geology of Natal, in South Africa," read before the Geological Society of London in 1871. While describing the Cretaceous deposits of the Pondoland coast, he mentions the fact of the occurrences of Cretaceous outcrops "on the Impenyati River and" "at some of the more southern rivulets which run into the sea" "between the boundary of Natal and the St. John's River (Umzim-" "vooboo). The same are also recognised in the bed of a small" "stream, running into the St. Lucia Bay, in the Zulu country." This

was in 1871, but the fossils from the Pondoland deposits, which are probably on the same horizon as those at the mouth of the Umpenyati River, had previously been described in 1855 by Mr. W. H. Baily, from a collection made in 1851 by Captain R. J. Garden, who visited the locality, accompanied by Mr. H. F. Fynn, who discovered these fossiliferous beds, in 1824. Shortly after Mr. Griesbach's visit and his description of the Cretaceous deposits on the south coast of Natal and Pondoland, reference is made, by Mr. St. V. W. Erskine, in his journey from Natal through Zululand and Portuguese territory to the mouth of the Zambesi River, of the presence of rocks that are now known to be of Cretaceous age in Zululand. With the exception of a reference in 1902 by Mr. W. Kilian on the presence of rocks of Aptien age in the neighbourhood of Delagoa Bay, this reference of Erskine's is the only mention of the presence of Post Triassic rocks on the coast of Zululand which has been made after an examination of the ground, until we find an allusion to the Cretaceous rocks in the Mining Reports of my friend Mr. J. J. Garrard in the later nineties, and in the First and Second Reports of the Geological Survey of Natal (1901 and 1904).

The following extract from Mr. A. Knox's "Notes on the" "Geology of the Continent of Africa" shows the references made by Mr. Erskine.

"From St. Lucia Bay northwards towards the Zambezi, the" "whole country is a sandy (red sand chiefly) flat, covered with bush," "the mountainous country lying further away towards the interior," "until the Limpopo is reached, when it is distant 200 miles" "from the coast. This coast ridge is formed of blown sand, and" "encircles the fertile soil of Inhambane; but as a rule the vast plain" "may be characterised as a 'mitigated desert.' This great lime-" "stone plain of South-East Africa is hemmed in by mountains on" "the west, and is somewhat curtailed towards the north by an" "extensive spur thrown out by them, towards the coast, and called" "Gorongosi, to the south of Sofala and near the Zambezi" (p. 85).

"The arenaceous limestone overlies a bright red sandstone in" "places. The remarkable deposits of lime become even more" "strikingly marked along the channel of the Sabi, where bluffs of" "pure lime and pebbles, 100 feet high, rapidly succeed each other" "for from 150 to 200 miles" (p. 27, Erskine, *J.R.G.S.*, 1878).

"Monjo country has a hard subsoil with outcrops of limestone" (p. 78, *ibid.*).

There is little doubt that the limestones and arenaceous beds referred to by Erskine as being present all the way up to the Zambesi mouth are representatives of the Upper Cretaceous Series, but in some isolated positions they are probably of Tertiary age, although limestones of the latter age are as yet rarely known on the Zululand littoral.

All the fossils obtained from the various localities where the exposures of these rocks have proved fossiliferous, in Natal and Zululand, belong to the Upper portion of the Cretaceous System.

The Pondoland deposits are also of the same age, and they are the furthest south representatives of the Upper Series, known to occur on the South African coast. From the mouth of St. John's River, past East London to Port Alfred, no rocks younger than the Beaufort Beds and the Ecca Series are known along the coast. St. John's and Port Alfred represent the two positions on the coast where the outcrops of the older rocks, the Table Mountain Sandstones in the one case and the Witteberg Series in the other, disappear into the sea. To the north of Port Elizabeth and in the basin of the Sunday River a large area is occupied by the Uitenhage Series, which has lately been proved by Mr. R. B. Newton and Mr. A. C. Seward to belong to the Lower Cretaceous period. As stated by Messrs. Hatch and Corstorphine in their "Geology of South Africa," the Upper Cretaceous is not represented in any part of Cape Colony, with the exception of the small outcrop on the coast of Pondoland. As regards these deposits in Natal and Zululand, it is certainly a fact that the entire sections of the series exposed at the mouth of the Umpenyati River and occurring in the bore at the Bluff, Durban, consist of Upper Cretaceous beds. In Zululand, however, we have not yet had a complete section of the series, either natural or in a bore. No bore has been sunk in the Cretaceous rocks except at the Umhlatuzi Lagoon, where the bore pierced only a few feet into the limestone below the Recent sands. It is true, that on the eastern flank of the Lebombo Range fossiliferous conglomerates, which are evidently beach deposits of Cretaceous age, occur, but as these are at a comparative height above the beds that are exposed near the present coast-line, they cannot be said to show that, underneath the Upper Cretaceous Series on the littoral of Zululand, some representatives of the Lower Cretaceous may not occur, because, even supposing that the beds have a slight easterly dip, to allow of the coming in of the comparatively thick series of Tertiary and Quaternary strata, it is not impossible that near the coast Lower Cretaceous beds may occur, but they will be at a considerable depth from the surface. So far as our present knowledge goes, no representatives of the Lower Cretaceous have yet been proved in Natal or Zululand. Although the core from the bore at the Bluff, Durban, showed over 300 feet of Cretaceous strata, the fossils were naturally fragments, and rare in their occurrence, but such forms as were recognisable belonged to an Upper Cretaceous fauna.

In Natal proper there are only two localities in which Cretaceous rocks are known to occur. One is at the mouth of the Umpenyati River on the south-east coast, and the other is in the bore which has been sunk on the seaward aspect of the Bluff, Durban. In the latter position at the Bluff, the Cretaceous beds were over 300 feet in thickness, and such fossils as were obtained in the core, although very fragmentary, showed that they belong to the upper portion of the system. There is no known exposure of these beds at the surface, although they may probably outcrop below the mud deposits of the bay, and probably form a portion of the sea-floor to the east. In the bore they are overlain by over 300 feet of

more recent calcareous sandstones, probably of Tertiary age. This latter series is considerably thicker when the rock of the Bluff above high-water mark is taken into account. The Upper Cretaceous beds rest unconformably on the Ecca Shales.

In a recent Monograph of the United States Geological Survey, a specimen of a Cephalopod in the Yale Museum collection, has been described by Professor Hyatt. This is the only specimen known, and in 1902 Professor Hyatt instituted a new genus for it, and it is now known as *Eulophoceras natalense*, gen. et spec. nov., Hyatt. The locality from which it was obtained is given as Port Natal, South Africa. As the presence of Cretaceous rocks at Port Natal has only recently been made known, and as no outcrops of them occur on the present land surface, it is unlikely to have been thrown up from the possible outcrop on the sea-floor, and I think it is more than probable that the actual locality from which it came was not Port Natal, but probably, it was a specimen which had been brought to the Port, either from the Upper Cretaceous deposits at the mouth of the Umpenyati River, on the south-east coast of Natal, or from the Cretaceous deposits on the coast of Pondoland.

The Upper Cretaceous Series in Alfred County, outcrop on the south-east coast, between high and low water marks, from about half a mile south of the mouth of the Umhlengeni River to close to the mouth of the Umpenyati River. Although the contact is nowhere exposed, the Cretaceous beds rest unconformably on the granitic rocks, which are exposed on the shore near the mouth of the Umhlengeni River and also to the south of the Umpenyati River. They lie practically horizontally, but from north to south there is a slight rise in the series, as if they dipped very slightly to the south-eastward. The lowest beds at the northern end of the outcrop consist of alternating calcareous shales, conglomerates, and arenaceous limestones, all of which are more or less fossiliferous. The conglomerates are very coarse, the pebbles being large, well-rounded, and occurring sprinkled through the matrix, but often in close-packed, horizontally disposed masses, occupying isolated positions throughout the rock. The shales are finer grained and calcareous, and in these the more delicate fossil organisms, such as the Echinid *Hemiaster Forbesii*, are preserved. Higher up in the series, to the south, towards the mouth of the Umpenyati River, the conglomerates disappear, and the beds consist entirely of shales and fine-grained sandy limestones. Among these higher beds the fossils are not nearly so plentiful as in the lower, but Cephalopoda are more numerous. The larger forms, *Schloenbachia Soutoni*, Baily, and *S. stangeri*, Baily, occur frequently in the upper beds, together with *Schloenbachia umbolazi*, Baily, and *Puzosia Gardeni*, Baily. The conglomerates are exceedingly fossiliferous, some flat eroded surfaces presenting simply a mass of shells and pebbles. On a large exposed surface of limestone, at the northern end of the outcrop, there is little else to be seen but the remains of the following Mollusca, all in detached valves, with the exterior upwards, and beautifully dissected out by the action of the

weather. The most common forms were *Arca umzambaniensis*, Baily, *Arca natalensis*, Baily, *Arca capensis*, Griesbach, *Trigonia Shepstonei*, Griesbach, *Trigonia elegans*, Baily, *Cardium denticulatum*, Baily, *Chemnitzia Sutherlandii*, Baily, *Turritella Meadii*, Baily, *T. multistriata*, Reuss, *Natica multistriata*, Baily, *Voluta rigida*, Baily, and indeterminable fragments of a much larger gasteropod. *Inoceramus* only occurs in broken fragments, which do not seem to have belonged to so large a species as that mentioned by Captain R. J. Garden in the Umtafuna Beds. Fragments of Chelonian scutes and Reptilian bones occur scattered throughout all the bed in quite an indiscriminate way. They are, however, very imperfect, as they had already undergone abrasion before their deposition in these deposits (see Dr. Broom's Report, p. 93). Fossil fish teeth, chiefly Selachian, are abundant in the lower beds among the invertebrate forms, together with the teeth of a Mosasaurian (see Dr. A. Smith-Woodward's Report, p. 99).

The beds do not extend any distance inland. In the cliffs fringing the lagoon at the mouth of the Umhlengeni River, slight evidences occur of their presence, but to a very limited extent, while their junction with the underlying granitic rocks is everywhere concealed from view by the Pleistocene and Recent sands of the coast.

These Upper Cretaceous beds on the Natal coast, agree both petrographically and palæontologically with the outcrops of Upper Cretaceous strata to the south, on the Pondoland coast, described by Baily, Griesbach, and lately by Rogers and Schwarz, of the Geological Survey of Cape Colony. As stated above, the Lower portion of the series is much more fossiliferous than the Upper, and it is not possible to divide the series into recognisable subdivisions. This will be more easily and satisfactorily accomplished when a more extended knowledge of the various outcrops of the Upper Cretaceous Series on the littoral of Zululand, where the whole series is much thicker and more widely developed, is obtained. It is true that the outcrops in Zululand are scattered, but already, by the great abundance of fossils which they contain, we are able to correlate certain horizons on different outcrops.

The majority of the fossil forms already described from the Pondoland deposits are common to the Umpenyati strata, but the Foraminifera have not yet been investigated. In extent of outcrop the Natal deposit is much less than that of Pondoland, where the beds are associated with Table Mountain Sandstones, against which, according to Rogers and Schwarz, they are faulted. Between the Umpenyati and Umtamvoona Rivers there is a small outcrop at the mouth of the Boboi River of horizontal sedimentary rocks, which do not contain any fossil remains, but which are probably an outlier of the same series of Cretaceous rocks. The beds of this small outlier undoubtedly rest unconformably on the granitic rocks, and although no junction is to be seen between the Umpenyati beds and the granite, there seems little doubt that they also rest unconformably

on the older rocks. At the lower part of the Umtamvoona River, where the Table Mountain Sandstones form the coast-line, there is no evidence of the presence of faulting, even of the most simple kind, and the absence of faulting is very marked over all this district among any of the other formations.

LIST OF FOSSILS FROM THE UPPER CRETACEOUS BEDS OF THE COAST OF PONDOLAND.

CEPHALOPODA.

Anisocerus rugatum, Forbes.
Baculites sulcatus, Baily.
Lytoceras Kayei, Forbes, sp.
Puzosia Gardeni, Baily, sp.
Puzosia rembda, Forbes, sp.
Schloenbachia Soutoni, Baily, sp.
Schloenbachia stangeri, Baily, sp.
Schloenbachia umbolazi, Baily, sp.
Eulophoceras natalense, Hyatt, gen. et. spec. nov.

GASTEROPODA.

Avellana ampla, Stol.
Cerithium (*Fibula*) *detectum*, Stol.
Chemnitzia Sutherlandii, Griesbach.
Cerithium kaffrarium, Griesbach.
Euchrysalis gigantea, Stol.
Fasciolaria assimilis, Stol.
Fasciolaria rigida, Baily, sp.
Lagena nodulosa, Stol.
Natica multistriata, Baily.
Pollia pondicherriensis, Forbes, sp.
Pugnellus uncatus, Forbes, sp.
Scalaria turbinata, Forbes, sp.
Solarium pulchellum, Baily.
Solarium Wiebeli, Griesbach.
Tritonidea trichinopolitensis, Forbes, sp.
Turbonilla undosa, Forbes, sp.
Turritella multistriata, Reuss.

SCAPHOPODA.

Dentalium, sp.

LAMELLIBRANCHIATA.

Alectryonia ungulata, Schlotheim, sp.
Arca capensis, Griesbach.

Arca umzambaniensis, Baily.
Arca natalensis, Baily.
Astarte, sp.
Axinæa africana, Griesbach, sp.
Cardium denticulatum, Baily.
Corbula like *C. Carinata*, d'Orbigny.
Cucullæa natalensis, Baily, sp.
Inoceramus expansus, Baily.
Meretrix arcotensis, Forbes, sp.
Neithea quinquecostata, J. Sowerby, sp.
Nucula, sp.
Ostrea, sp.
Pecten amapondensis, Griesbach.
Poromya ?
Protocardium Hillanum, J. Sowerby, sp.
Teredo, sp.
Trigonia elegans, Baily.
Trigonia Shepstonei, Griesbach.
Lucina, sp.

ECHINODERMATA.

Hemiaster Forbesii, Baily.
Holaster indicus, Forbes.
Diadema, sp.

Chelonian bones have been recognised by Professor Owen from these deposits.

FORAMINIFERA.

Haplophragmium neocomianum, Chapman.
Haplophragmium meridionale, Chapman, sp. nov.
Bulimina trigonula, nom. nov., Chapman, var. *inornata*, nov.
Pleurostomella subnodosa, Reuss.
Nodosaria prismatica, Reuss.
Nodosaria zippei, Reuss.
Vaginulina humilis, Reuss, sp.
Vaginulina legumen, Linn., sp.
Vaginulina intumescens, Reuss.
Cristellaria subalata, Reuss.
Polymorphina (?) *gibba*, d'Orb.
Globigerina canaliculata, Reuss, sp.
Truncatulina Schloenbachi, Reuss, sp.
Pulvinulina elegans, d'Orb., sp.
Pulvinulina Carpenteri, Reuss, sp.
Pulvinulina reticulata, Reuss, sp.
Pulvinulina pondensis, Chapman, sp. nov.
Rotalia soldanii, d'Orb., sp., var. *nitida*, Reuss.

OSTRACODA.

Macrocypris simplex, Chapman.
Bythocypris simulata, Jones, sp.
Cythere (?) *drupacea*, Jones.
Cythereis ornatissima, Reuss, sp., var. *reticulata*, Jones and Hinde.
Cytheridea longicaudata, Chapman, sp. nov.
Cytheropteron elongato-concentricum, Chapman, sp. nov.
Cytherella Williamsoniana, Jones.

SPONGIDÆ.

Pachastrella haldonensis, Carter.

From the Umpenyati River deposits :—

REPTILIA.

Simoliosaurus, sp.
Liodon, sp.

PISCES.

Cestracion, sp.
Scapanorhynchus subulatus, Ag.
Scapanorhynchus, sp., or *Odontaspis*, sp.
Oxyrhina aff. Mantelli, Ag.
Lamna basalis, Egerton.
Corax falcatus, Ag.
Enchodus, sp.

In Zululand the outcrops of the Cretaceous formation are entirely confined to the littoral, which has practically been formed by the elevation of the Cretaceous and Tertiary sea-floor, and has subsequently been covered with the Pleistocene and Recent sandy deposits. No representatives of this formation are known to occur anywhere on the high lands of the interior. This is an obvious result from the fact, that the interior had already become dry land before the deposition of the littoral Cretaceous strata. The outcrops are necessarily limited in extent and only occur at very frequent intervals, because of the superficial covering of sand. The actual coast-line, where sections of these strata are exposed among the sand-dunes, I have satisfied myself, consists generally of Tertiary and more Recent deposits. The furthest south point at which Cretaceous rocks are known to be present in Zululand is on the north side of the Umhlatuzi Lagoon, close to the coast, but it is probable that they are also present under the more superficial deposits nearly as far south as the Umlalaaz River, where the littoral is at its narrowest. At Port Durnford, there is a cliff section containing a bed of impure lignite,

overlaid by a series of false-bedded sands, which can quite easily be identified with sections higher up the coast, which undoubtedly overlie beds of Tertiary age containing marine fossils. It is therefore probable that the underlying Cretaceous rocks extend some distance south of Port Durnford towards the Umlalaaz River. The limestone at the bottom of the bores north of the Umhlatuzi Lagoon is probably the nearest occurrence of the Cretaceous Series to the coast. Away to the north, on the eastern flank of the Lebombo Range, outcrops of Cretaceous strata occur 50 miles from the coast, and most of the other known outcrops are a considerable distance inland.

No representatives of this formation are present on any part of the north coast of Natal, from the Cretaceous beds discovered in the bore at the Bluff, Durban, to the Umhlatuzi Lagoon on the south coast of Zululand. To the northward of Emtini, at the junction of the Ingwavuma and Pongola Rivers, the furthest north outcrop in Zululand, Cretaceous rocks are known to occur at Delagoa Bay, Sofala, Mozambique, and still further north, all the outcrops being on the littoral. Such fossils as have been described from these localities have in all cases proved to belong to some portion of the Upper Cretaceous Series; but naturally these localities have been few in number and widely separated, as the countries are very little known, except to hunters, who do not, as a rule, take an interest either in geology or palæontology.

The bores which were sunk immediately to the north of the lagoon, near the mouth of the Umhlatuzi River, after passing through about 90 feet of sand, struck an arenaceous limestone, which was very prolific in fossils. These were undoubtedly of Upper Cretaceous age, and were identifiable with some of those occurring in the limestone of Umkwelane Hill, Isitesa Lake, on the south side of the Umfolosi River, which were described by Mr. R. Etheridge in the Second Report of the Geological Survey of Natal and Zululand at p. 73. The limestone in the two localities, which are 20 miles apart, is almost identical petrologically. These bores are recorded by Mr. J. J. Garrard in the Mining Reports of Zululand.

The first surface outcrop of the Cretaceous rocks to the north occurs at Umkwelane Hill, mentioned in the last paragraph. It is entirely confined to the hill, on the west of which an extensive area is occupied by diabase, while immediately to the east the hill is skirted by the Isitesa Lake and the flat, swampy littoral of the coastal portion of the Umfolosi River. The rocks forming this outcrop comprise an impure limestone of a bluish-grey colour, overlaid by an earthy coloured calcareous sandstone. The limestone is abundantly fossiliferous, but few specimens are present in the overlying sandstone. A notice of this deposit appears at p. 49 of the First Report of the Natal Geological Survey, and Mr. R. Etheridge, after describing the fossils from this locality, concluded that the beds are of Upper Cretaceous age.

LIST OF FOSSILS FROM THE UPPER CRETACEOUS BEDS OF UMKWELANE HILL, ZULULAND.

PELECYPODA.

Ostrea, sp.
Exogyra, sp.
Neithea, sp.
Melina Andersoni, Etheridge, sp. nov.
Gervillia, sp.
Pinna, sp.
Mytilus, sp.
Trigonia umkwelanensis, Etheridge, sp. nov.
Trigonarca umzambaniensis, Baily, sp.
Latiarca (*?*) *natalensis*, Baily, sp.
Cardium Bullen-Newtoni, Etheridge, sp. nov.
Protocardium Hillanum, J. Sowerby, sp. var.; *umkwelanensis*, Etheridge, var. nov.
Eriphyla lenticularis, Goldfuss.
Eriphyla (*?*) *Rupert Jonesi*, Etheridge, sp. nov.
Cytherea (*?*) *kaffraria*, Etheridge, sp. nov.
Cicatrea, sp.
Tapes, sp.
Donax Andersoni, Etheridge, sp. nov.
Mactra (*?*) *Zulu*, Etheridge, sp. nov.
Corbula, sp.

GASTEROPODA.

Alaria (*?*) *Bailyi*, Etheridge, sp. nov.
Fulguraria, sp.
Zaria Bonei, Baily.
Pyropsis, sp.
Patella, sp.
Cylichna Griesbachi, Etheridge, sp. nov.
Cylichna fusuliniformis, Etheridge, sp. nov.
Actæonina Atherstonei, Sharpe, var.; *umkwelanensis*, Etheridge, var. nov.
Gyrodes (*?*), sp.
Chemnitzia, sp.
Solarium, sp.

CEPHALOPODA.

Placenticeras kaffrarium, Etheridge, sp. nov.
Placenticeras umkwelanensis, Etheridge, sp. nov.
Creniceras (*?*), sp.
Hamites, sp.
Baculites, sp.

PISCES.

Lamna, sp.
Fish spine indeterminable.
Scapanorhynchus rhaphiodon, Ag.
Fish scales, which may be Cœlacanth or Palæoniscid.

At the common exit of the Umfolosi River and the drainage of St. Lucia Lake into the sea, at St. Lucia Bay, outcrops of calcareous sandstones occur, but so far as examined they are unfossiliferous, and therefore cannot be assigned definitely to the Cretaceous Period. Further north, near Cape Vidal, other outcrops occur which cannot be identified as belonging to the Cretaceous, but from evidences from other parts of the coast I would be inclined to think that in both cases they will prove to be of Tertiary age. While I am touching on this subject, I may state that at many isolated points, at which I have been able to reach the coast further north, including Cape Vidal, Uqobelatini Lake, Sordwana Point, east end of Lake Sibayi, and the outlet of Kosi Bay, calcareous sandstones occur either *in situ* or as isolated boulders. The only fossil remains they contain are Foraminifera, and they closely resemble the foraminiferal calcareous sandstones of the south part of the coast, at Port Durnford, &c. It is more than probable that in time to come, when this difficult and dreary country is better known, the rocks of the immediate coast will prove to be of Tertiary age.

At many points round the edges of St. Lucia Lake and False Bay low outcrops of horizontally bedded strata occur, chiefly calcareous marls and sandstones, but I have only had an opportunity of a cursory examination of a few of these. From the western bank of False Bay, at the game reserve, in beds exposed on the game pad, which passes along the beach of the lake between the water and the heavy game cover of jungle on its bank, I obtained some fragmentary fossils, very badly preserved, which Mr. Etheridge was inclined to think belonged rather to the Tertiary than to the Cretaceous System. If this be so, the extension westward of the Tertiary System is considerable; but between False Bay and the outcrop of the Rhyolite at the southern end of the Lebombo Range, Cretaceous beds occur, showing frequent outcrops, most of them containing characteristic Cretaceous fossils.

With the exception of these rock outcrops on the edges of St. Lucia Lake and False Bay, no outcrops of sedimentary rocks have yet been met with on the littoral until where the main northern wagon-track used to cross the Umsinene River, which ultimately joins the Manuan Creek and flows into the head of False Bay. This crossing of the Umsinene River, which was always a bad one, is not now used, but there are exposed in the bed of the creek a series of sandstones which are slightly calcareous but contain no fossils. From their stratigraphical position with regard to the Cretaceous deposits, to be mentioned later, it would seem to me that they are also Cretaceous.

Immediately to the west of the littoral here, the hilly country is

formed of the Lebombo Rhyolites, which have from this point northward, past the Portuguese border, formed the Cretaceous sea coast; and where the line of union between the Rhyolite and the littoral occurs, the beach of the Cretaceous sea is shown to have existed by the occasional outcrops of fossiliferous Cretaceous conglomerates.

The Manuan Creek, which joins the Umsinene River before its entrance into False Bay, has three tributaries, over each of which the northern wagon-track passes. Near each of the three crossings, outcrops of Cretaceous rocks occur containing fossils. The fossils from the outcrops at the most southerly tributary are described by Mr. R. Etheridge as Part II. of the "Cretaceous Fossils of Natal," in the present Report of the Geological Survey (p. 67), under the title of the "Umsinene River Deposit." This name does not describe accurately the position of the deposit from which the fossils that are described came, but owing to the fact that there are four fossiliferous deposits all in a small portion of the Manuan Creek basin, the name "Umsinene deposit" refers to the deposit occurring immediately to the north of the crossing of the most southerly tributary of the Manuan Creek. The others are at the crossing of the middle and the northern tributary, to the east of Crossly's store, while the fourth locality is near, but to the west of, the junction of the Manuan Creek with the Umsinene River.

The outcrop of the "Umsinene deposit" is of limited extent and is exposed chiefly in the bed of the southernmost tributary of the Manuan Creek, and on the rising ground to the north of it, and it again appears where the wagon-track crosses the next spruit to the north. The rock is a calcareous, argillaceous, fine-grained sandstone of a brownish colour, with fossils scattered sparingly through it. Below I give a list of the fossils from this horizon, which have been described by Mr. R. Etheridge, who concludes, from his examination of the specimens: "As the general facies of the Umsinene" "fossils resembles that of the Umkwelane Hill bed, I am induced to" "regard them simply as horizons in one and the same geological series." These two deposits are 40 miles apart, but occur close to the western limit of the Cretaceous formation. In both cases they have an undoubtedly Upper Cretaceous facies.

LIST OF FOSSILS FROM THE UPPER CRETACEOUS BEDS OF THE UMSINENE RIVER, ZULULAND.

ECHINODERMATA.

Hemiaster (*?*), sp.

ANNELIDA.

Serpula pinchiniana, var.; *umsinenensis*, var. nov.

PELECYPODA.

Ostrea, sp.
Neithea quinquecostata, J. Sowerby.
Entolium (?) *Andersoni*, Etheridge, sp. nov.
Pseudavicula (?) *africana*, Etheridge, sp. nov.
Gervillia dentata, Krauss.
Inoceramus volviumbonatus, Etheridge, sp. nov.
Axinæa subauriculata, Forbes.
Cucullæa (?) *umsinenensis*, Etheridge, sp. nov.
Trigonia ventricosa, Krauss.
Protocardium cinctutum, Etheridge, sp. nov.
Astarte Hertzogi, Krauss.
Veniella (?) *sanctæ-luciensis*, Etheridge, sp. nov.
Cytherea (?), sp.
Pleuromya (?), sp.
Myopsis (?) *africana*, Etheridge, sp. nov.
Glycimeris Griesbachi, Etheridge, sp.
Parapholas Tatei, Etheridge, sp. nov.
Teredo (?), sp.

GASTEROPODA.

Actæon, sp.
Zaria (?), sp.
Solarium Hedleyi, Etheridge, sp. nov.
Pseudamaura terrazulensis, Etheridge, sp. nov.
Alaria (?) *Bailyi*, Eth. fils.

CEPHALOPODA.

Douvilleiceras (?) *nodosa*, Etheridge, sp. nov.
Desmoceras, sp.
Hamites, sp.

The next deposit occurs on the middle tributary of the Manuan Creek to the north. Where the wagon-track crosses this creek the rock is Rhyolite, which persists right to the source of the creek. Below the crossing the right-hand bank is entirely of Rhyolite, while on the left-hand bank a small outcrop of fossiliferous Cretaceous rocks occurs, which is exposed in a mealie garden belonging to the neighbouring kraal. The outcrop is a very small outlier, exposed on the slope of the northern bank of the creek, and is completely isolated on the Rhyolite. This exposure passes along the north side of the creek for a distance of a few hundred yards. The strata, as exposed in the cliff, which is about 20 feet in height, consists of a dirty grey-brown calcareous sandstone, which contains the chief specimens of the Cephalopoda, both Ammonites and Nautili. Below this, about 15 feet of shales and marls, chiefly containing Mollusca and other forms.

Near the top of the shale outcrop there is a thin layer in which small Echinids occur in great abundance.

The fossils from this deposit are described by Mr. G. C. Crick, of the British Museum, in this Report under the title of "The South Manuan Creek Deposit."

At intervals Cretaceous beds crop out in the bed of the northern tributary of the Manuan Creek as far west as the point, where the Mkuzi River track crosses the creek, at the foot of the hill to the east of Crossly's store. In the lower part of the creek the beds are calcareous sandstones but contain few fossils. In the upper portion, however, the rock is a coarse conglomerate, which contains abundant fossil remains, chiefly Mollusca. The matrix is light yellow in colour and very calcareous. The pebbles are chiefly quartzites and igneous rocks. At p. 49 of my First Report I stated that pebbles of Rhyolite were not observed, but, since then, I have noticed undoubted specimens of the Lebombo rock in these conglomerates. The fossils from this deposit have not yet been described. From the character of the rock they are very imperfect, and are not well preserved.

The other fossiliferous Cretaceous deposits which I have been able to visit and make collections from, are situated near the junction of the Manuan and the Umsinene Rivers. The exposure shows a thicker series of beds than in any other locality from which I have collected. There are from 70 to 100 feet of strata exposed, chiefly calcareous sandy shales and sandstones, the whole being capped by a very hard calcareous sandstone full of broken shells. The beds are exposed almost continuously where the bank is precipitous. They are exceedingly prolific in fossils, chiefly Mollusca, Cephalopoda, and Gasteropoda. The Cephalopoda are extremely abundant, and range in size from forms of half an inch to over a yard in diameter. The fossils weather from the shales in a perfect condition, but from long exposure on the surface to the atmosphere, rains, and bush fires, they are largely composed of casts. Some good specimens, however, were obtained. These are described by Mr. G. C. Crick, of the British Museum, in this Report, under the title of the "North End of False Bay Deposit."

There are many other localities in the neighbourhood of False Bay where the Cretaceous rocks are exposed, but collections of fossils from them have not yet been obtained. It is quite likely that, when the various river-beds which cross the littoral area have been examined, and a more intimate knowledge has been obtained of the other lakes in this region, many fossiliferous outcrops of Cretaceous rocks will be met with. Although these Upper Cretaceous rocks outcrop on the littoral of East Africa for a long way to the north, it is here, in Zululand, where the earliest thorough knowledge of the series should be obtained, as the coast to the north is not likely to be opened up by Europeans for a very long time to come.

The Cretaceous rocks to the east of Crossly's store, near the southern end of the Lebombo Range, was the furthest north from which I have yet obtained fossils; but other outcrops are known

to occur, containing fossils, which I have not had a chance of visiting. Fossiliferous conglomerates are known to occur at the Mkuzi Poort, at the base of the eastern flank of the Lebombo Range. Another series of fossiliferous conglomerates also occurs at Umtini, close to Wessels and Fenetti's store, immediately to the north of the junction of the Ingwavuma and Pongola Rivers.

The only other outcrop of rock that I have come across in this great expanse of the northern littoral is in the creek bed at Magusa, which used to be the old Magistracy called Foxon's Camp, in the middle of the flat country to the south-west of the southern end of Kosi Bay. Here there is an unfossiliferous calcareous sandstone which much resembles the foraminiferal rocks of the coast, and to which I have referred as Tertiary.

The following list of papers, &c., contains those known to me which make reference to the Cretaceous rocks of South-East Africa.

NOTE, p. 50.—Since this article has been in print, Mr. G. C. Crick informs me that he has identified specimens of *Eulophoceras natalense*, Hyatt, among fossils from the Cretaceous of the south-coast of Natal.

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CRETACEOUS FOSSILS OF NATAL.

PART II.—THE UMSINENE RIVER DEPOSIT, ZULULAND.

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therefrom. As to the fossils, they are on the whole fragmentary and poorly preserved, although in a few instances this is not the case. This poor state of preservation has rendered specific identification difficult and often unsatisfactory. At the same time sufficient evidence exists to indicate that careful and persistent collecting would lead to good results, and probably to a much richer fauna.

II.—DESCRIPTION OF THE SPECIES.

1. ECHINODERMATA.

GENUS HEMIASTER (*Desor*), *L. Agassiz*, 1847.
(Ann. Sci. Nat., 1847, viii. (3), p. 16.)
HEMIASTER?, *sp.*
(Pl. II., Figs. 13 and 14.)

Obs.—The specimen consists of a portion of an irregular Euechinid, comprising rather more than the anterior half of the test, with the inferior surface covered with matrix; the positions of the oral and anal orifices are, therefore, not visible, and there is no trace of fascioles. It is a mere cast in poor condition, and is apparently allied to *Hemiaster Forbesi*, Baily,* of the Umtafuna beds. The ambulacral impressions are not so widely petaloid as in the species named, nor so deeply excavated. The anterior, or odd, ambulacrum extends round on to the inferior surface; it is not possible to count the pores.

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2. ANNELIDA.

GENUS SERPULA, *Linnæus*, 1758.
(Systema Nat., Ed. X., 1758, p. 786.)
SERPULA PINCHINIANA, *var.* UMSINENENSIS, *var. nov.*
(Pl. I., Figs. 1–6.)

Sp. Char.—Tube large, up to 7 mm. in diameter, aggregated but rambling, and in places the tubes only feebly connected with one another, thick, round or oval, more or less straight, or curved, the curvature varying in degree to nearly semicircular. Exterior, when perfect, smooth and shining, when weathered exhibiting a concentrically lined and roughened appearance; longitudinal ridges absent; varices occasionally present. Test 1 mm. thick; structure laminar-vesicular, the outer layer vesicular or structureless, attaining a thickness of 0·2 mm., the vesicles small, round, and irregularly spaced

* Quart. Journ. Geol. Soc., 1855, xi., p. 463, t. 12, f. 1*a–c*.

apart; inner layer laminar, 0·65 mm. in thickness, and sometimes separable into two layers.

Obs.—The test is distinctly divisible into two layers, the outer laminar and vesicular at one and the same time, the inner homogeneous and different in colour. The dual testiferous layers are accepted as evidence of the annelide nature of this organism.* An interesting feature in connection with these layers is noticeable in Pl. I., Fig. 4, where it will be seen that the outer laminar-vesicular layer is not always continuous around each inner layer, but sometimes enfolds two of the latter. It is possible that the semicircular tube (Pl. I., Fig. 5) may be the distal end of one of the straighter portions. There are no longitudinal ridges, or keels, thus resembling such forms as *Serpula flagellum*, Goldfuss,† with which it is also in accord in the presence of the rough concentrically lined external surface.

The late Professor R. Tate referred to a *Serpula* as a "large," single tube,"‡ recorded by Mr. D. Sharpe § from the Sunday River and Zwartkop beds; this he named *S.* (*Vermilia*) *pinchiniana*,‖ and as one of its characters said it did not possess annular rings, but at the same time he distinctly figures such a feature; these rings are present on one of our specimens, and also a longitudinal impressed line, similar to that seen on many species of *Serpula*. This line is not shown on either of Tate's figures. Whether or no the tubes from the Umsinene deposit should be referred to *S. pinchiniana*, or not, it is very difficult to say, but with the view of leaving the question an open one, I have applied a varietal name to them.

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3. PELECYPODA.

Genus Ostrea, *Linnæus*, 1758.

(Systema Nat., Ed. X., 1758, p. 696.)

(Pl. II., Fig. 7.)

Obs.—As in the case of the Umkwelane Hill beds, the presence of this genus is here shown by imperfect specimens, two in number.

1. A geniculate outlined flat valve, much exfoliated; it is square-ended above, with a straight cardinal margin. The adductor impression is visible (Pl. II., Fig. 7).

2. Remains of a very much larger exfoliated flattened valve, long-oval in outline.

These are of little importance beyond a mere record of the genus.

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* See Nicholson, Man. Palæontology, 3rd ed., 1889, p. 473, f. 335B.
† Goldfuss, Petrefacta Germaniæ, t. 69, f. 5*a* and *b*.
‡ Tate, Quart. Journ. Geol. Soc., 1867, xxiii., p. 163.
§ Sharpe, Trans. Geol. Soc., 1856, vii. (2), p. 202.
‖ Tate, Quart. Journ. Geol. Soc., 1867, xxiii., p. 163, t. 9, f. 10*a–c*.

GENUS NEITHEA, *Drouet*, 1824.
(Ann. Soc. Linn. Paris, 1824, iii., p. 183.)
NEITHEA QUINQUECOSTATA, *J. Sby.*
(Pl. IV., Figs. 8 and 9.)

Pecten quinquecostata, J. Sby., Min. Conch. Gt. Brit., 1814, i., p. 122, t. 56, f. 4–8.
Pecten quinquecostatus, Baily, Quart. Journ. Geol. Soc., 1855, xi., p. 462.
Vola quinquecostata, Stoliczka, Cretaceous Fauna S. India (Pal. Ind.), iii., Pelecypoda, 1871, p. 427, t. 31, f. 1–6, t. 37, f. 4–9.

Obs.—Mr. J. H. Baily recorded this shell from the Umtafuna beds (= Izinhluzabalungu deposits of Griesbach) as a "small but" "perfect specimen." In the present collection is a small convex valve that I cannot distinguish from Sowerby's species. The latter writer said: "Convex valve gibbous, ribbed, principal costæ six, with four" "lesser ones between each; surface finely transversely striated."

In our specimen there are also six primary costæ, and between them four secondary, except in one intercostal space where there are five, but the transverse crenulations are nearly worn off, and the small auricles broken away.

Examples examined by Stoliczka from the Ootatoor, Trichinopoly, and Arrialoor Groups of the South Indian Cretaceous were observed to possess from two to four secondary costæ in the intercostal spaces. The South African valve also corresponds with some of the Indian in that the two median of the secondary costæ in each intercostal space are somewhat coarser than the two lateral. Of the primary costæ, the two median, occupying the arch of the valve, are more prominent than the others.

GENUS ENTOLIUM, *Meek*, 1865.
(Progress Report Geol. Survey California, 1865, i., App. B, p. 478.)

Obs.—The type of this genus, or sub-genus, as written by most authors, is *Pecten demissus*, Phillips. Professor A. E. Verrill founded his genus *Protomusium** also on the same species, and the latter must therefore be considered a synonym of *Entolium*. Verrill apparently overlooked Meek's very explicit statement as to the type species selected by him, and makes *Pecten cornutum*, Quenstedt, the type of *Entolium*.†

* Verrill, Trans. Connecticut Acad. Arts and Sci., 1899, x., Pt. 1, p. 71.
† *Ibid.*, p. 62.

ENTOLIUM (?) ANDERSONI, *sp. nov.*

(Pl. II., Fig. 12.)

Sp. Char.—Valve sub-orbicular, lenticular, compressed, slightly arched in the middle line from the umbo forwards, the remainder of the valve being flattened; cardinal margin very short; umbo fine and very pointed; auricles small, flat, triangular, alike, equal, and with their dorsal margins horizontal; sculpture (if any) not preserved.

Obs.—Only one valve is present, but as no Pectinoid shell of this group has, so far as I know, been described from the Cretaceous rocks of South Africa, I think it well to bestow a name on it, and have much pleasure in associating that of my esteemed friend. The valve presents all the external features of an *Entolium*, but I have not seen its internal characters.

Entolium (*?*) *Andersoni* is distinguished from the generic type, *P. demissus*, Phillips,* by its more dorsally attenuated outline, and as a result a greater proportionate enlargement ventrally. The first of these features also separates it from Meek's American Mesozoic type—*E. aurarium.*† It also appears to be a proportionately longer shell than most of the species referred by Mr. E. Philippi to the genus,‡ amongst others:—*E. discites*, Quenstedt, of the Trias; *E. cornutum*, Quenstedt, of the White Jura; *E. vitreus*, A. Roemer, of the Malm formation; and the following Upper Chalk species, viz.: *E. membranaceus*, Nilsson, *E. nummularis*, D'Orb., *E. laminosus*, Mantell, and *E. Nilssoni*, Goldfuss. The obtuse longitudinal ridge from the umbo downwards also appears to be a distinctive feature. From *E. nummularis* and *E. laminosus* the present form is also distinguished by the absence of the concentric sculpture of the two former species.

In outline *E. Andersoni* seems to be nearest akin to a shell of the Ootatoor Group, named by Stoliczka *Pecten* (*Syncyclonema*) *obovatus*,§ but again the latter is concentrically sculptured.

GENUS PSEUDAVICULA, *Eth. fil.*, 1892.

(Geol. Pal. Q'land, &c., 1892, p. 449.)

PSEUDAVICULA (?) AFRICANA, *sp. nov.*

(Pl. II., Figs. 8–11.)

Sp. Char.—Shell small, equivalve (?), oval-orbicular, both valves alike, and very gently convex; cardinal margins as long as the width of the valves, straight posteriorly, and slightly inclined obliquely down-

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* Phillips, Ill. Geol. Yorksh., Pt. 1, t. 6, f. 5.

† Meek, Progress Report Geol. Survey California, 1865, i., App. B, p. 478, t. 1, f. 6, 6A.

‡ Philippi, Zeit. Deuts. Geol. Gesellschaft, 1900, lii., pp. 80–81.

§ Stoliczka, Cretaceous Fauna S. India (Pal. Ind.), iii., Pelecypoda, Pts. 9–13, 1871, p. 435, t. 32, f. 7 and 8.

wards anteriorly; umbos very small and non-projecting, nearly central; anterior margins gently rounded, no anterior auricle; posterior ends flattened above and somewhat alate, or wing-like, the margins even and non-sinuate. Left valve covered with distant, simple, fine, linear costæ not reaching to the umbo. The right valve devoid of costæ, but both valves with concentric latilaminæ. Hinge plates apparently provided with a simple marginal thickening only; adductor scars subcentral, nearer to the posterior than anterior margins; pallial line defined by a line of minute muscle pits. Test structure lenticular-laminate, glistening, similar to that of the genus *Maccoyella.**

Obs.—Small orbicular valves, all to some extent exfoliated and without any well-defined characters of their own, are represented in this collection by a number of examples. Similar small bivalves occur in the Lower Cretaceous of Queensland,† and from a like difficulty were only briefly described but not named. At one time I took these to be species of Whitfield's genus *Meleagrinella*,‡ but neither the remarkable auricle of the right valve nor the fold along the dorsal margin is represented in either the Australian or South African specimens; the outline, omitting the first of these features, is exactly that of *Meleagrinella*. The reference to *Pseudavicula* can only be regarded as provisional, for the characters of the articulus of the two described species of the latter, as well as that of the Queensland shells referred to above, is at present too little known to warrant one in speaking with certainty. All that can be said just now is that the specimens now before me agree better with characters of *Pseudavicula* than with those of any other related genus. The articulus of *Pseudavicula*, so far as I know it, appears to possess a simple thickened margin in each valve, leaving grooves in casts, and such is the case here also. These South African shells certainly cannot be referred to either *Oxytoma*, Meek, or *Eumicrotis*, Meek. Outside the Queensland Cretaceous area the only ally appears to be *Pseudomonotis* (*?*) *inops*, Stoliczka,§ of the Indian Arrialoor Group, with which it is quite possible they may be congeneric. This species, however, cannot be included in *Pseudomonotis*, as typified by *Gryphæa speluncaria*, Schlotheim, for the simple reason that left valves only are known.

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* Etheridge, Junr., Geol. Pal. Q'land, &c., 1892, p. 454; Mem. Geol. Survey N. S. Wales, Pal. No. 11, t. 1, f. 5.

† Etheridge, Junr., Geol. Pal. Q'land, &c., 1892, p. 483, t. 21, f. 14–16.

‡ Whitfield, Mon. U.S. Geol. Survey (Powell's), 1885, ix., p. 71.

§ Stoliczka, Cretaceous Fauna S. India (Pal. Ind.), iii., Pelecypoda, Pts. 9–13, 1871, t. 38, f. 7, 7*a*, 8.

GENUS GERVILLIA, *Defrance*, 1820.
(Dict. Sci. Nat., 1820, xviii., p. 502.)
GERVILLIA DENTATA, *Krauss* (?).
(Pl. I., Figs. 13–15.)

Gervillia dentata, Krauss, Nova Acta Acad. Cæs. Leopol.-Carol. Nat. Cur., 1850, xxii., p. 458, t. 50, f. 1*a-c*.

Sp. Char.—Shell transversely elongated, or elongately triangular, expanding slightly towards the posterior; cardinal and ventral margins subparallel, the former erect, but neither curved nor arched, and bearing a few large, deep, and wide-apart resilifers; no diagonal ridges, the valve surfaces uniformly rounded and becoming flattened ventrally; umbos quite terminal. Test greatly thickened and markedly laminar; sculpture of wide, concentric latilaminæ, and no trace of radii.

Obs.—In addition to the figured example there are several portions, remarkable for their great thickness of test, the various layers of which are easily discernible; there is no trace of a prismatic structure. By a little careful manipulation I succeeded in clearing out the matrix from between the high and outwardly straight-walled dorsal margins of the valves, revealing traces of three large and wide-apart resilifers, as in Krauss's figure of his *Gervillia dentata*; the dental structure of the articulus has not been seen. The resilifers are fewer in number than in Krauss's figures, but this is probably due to mal-preservation only.

There is also a general resemblance to *G. aviculoides*, J. de C. Sby.,* of the Lower Greensand, and *G. anceps*, D'Orb.,† a Neocomian species.

GENUS INOCERAMUS (*J. Sby.*), *Parkinson*, 1819.
(Trans. Geol. Soc., 1819, v., p. 55.)
INOCERAMUS VOLVIUMBONATUS, *sp. nov.*
(Pl. II., Figs. 1–6.)

Sp. Char.—Shell subquadrate, very tumid, strongly biconvex, alate posteriorly, and apparently equivalve; cardinal margins long and straight; ventral margins rounded; umbonal regions high, prominent, longitudinally arched, but rounded and somewhat compressed transversely, curving over towards the anterior cardinal margins; umbos quite anterior, closely inrolled. Anterior ends barely developed, the margins swelling out slightly below; posterior slopes not differentiated from the rounded compressed umbonal regions, and passing insensibly

* Sowerby, Min. Conch. Gt. Brit., 1826, vi., t. 511.
† D'Orbigny, Pal. Franç. Terr. Crét., iii. (Lamellibr.), 1846, t. 394.

into the somewhat flattened alate posterior ends, the margins of which are obliquely rounded, and so are the posterior cardinal angles also. Resilifers close, quadrangular. Sculpture of sharp, outstanding, concentric ridges in the young state, which become wider and wider apart towards the ventral margins, the interspaces following the general curvature of the valves. Closer, far more numerous, and angular in the mature condition.

Obs.—This is a very remarkable form, with a high and prominent umbonal region in each valve, terminating in overturned and inrolled umbos, resembling that of the large valve of *I. involutus*, J. de C. Sby.,* from the Upper Chalk, but free, and hardly embraced by the valve border; and *I. umbonatus*, Meek and Hayden,† from the Fort Benton Group of the Missouri Cretaceous. The dissimilarity of the valves in both species at once separates them from the present form, but otherwise the latter is remarkably like the convex valve of *I. umbonatus* in possessing the same wide-apart, concentric, outstanding ridges. The sculpture undergoes change with age. The distant outstanding sharp concentric ridges of the young shell (Pl. II., Figs. 5 and 6) give place to close angular rugæ of the true *Inoceramus* type (Pl. II., Figs. 1 and 2). At first sight these conditions inspire the eye with the idea of different species, but in the series of specimens before me there are so many gradations that this view becomes untenable.

In speaking of the Umtafuna beds, Captain R. J. Garden said the lowest horizon but one of the section, a brownish-red sandstone, is "traversed in every direction with white veins, which are the broken" "edges of colossal bivalve shells (*Inoceramus*)."‡ This shell was described by Mr. W. H. Baily as *I. expansus*,§ but differs entirely from *I. volviumbonatus*, being a depressed and dilated species.

In the first part of this Memoir I described a shell under the name of *Melina Andersoni*, relying on the structure of the articulus, which appeared to be more that of *Melina* than *Inoceramus*. The occurrence of the present shell, however, with its unmistakable umbonal resemblance to the species named above, and the similarity of the articulus of *I. Andersoni* to that of *I. volviumbonatus*, suggests a more appropriate reference of the former to *Inoceramus* rather than to *Melina*. At the same time the apparent equality of the valves, inrolled and separated umbos, precludes the reception of *I. volviumbonatus* in either of the sections into which Meek has subdivided the genus *Inoceramus*.

I. Andersoni and the present species are not identical, as might at first be surmised. The two differ thus:—(1) The former lacks the high umbonal elevation and inrolled umbos of the latter; (2) the

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* Sowerby, Min. Conch. Gt. Brit., 1828, vi., t. 583.

† Meek, Rept. U.S. Geol. Survey Terr. (Hayden's), 1876, ix., t. 3, f. 1*c*, t. 4, f. 2*a* and *b*.

‡ Garden, Quart. Journ. Geol. Soc., 1855, xi., p. 453.

§ Baily, Quart. Journ. Geol. Soc., 1855, xi., p. 462, t. 13, f. 5.

surfaces of the valves are in consequence less tumid, more depressed, and more evenly convex; (3) the outline of the valves is more quadrate in *I. Andersoni*.

GENUS AXINÆA, *Poli*, 1791.
(Testacea, 1791, i.)
AXINÆA SUBAURICULATA, *Forbes* (?).
(Pl. I., Figs. 11 and 12.)

Pectunculus subauriculatus, Forbes, Trans. Geol. Soc., vii. (2), p. 150, t. 17, f. 13.
Axinæa subauriculata, Stoliczka, Cret. Fauna S. India (Pal. Ind.), iii. (Pelecypoda), Pts. 5–8, 1871, p. 349, t. 17, f. 31, 32.

Obs.—The shells so referred are distinct in outward form from *Axinæa africana*, Griesbach,* sp., but I am quite unable to separate them from Stoliczka's figures of *A. subauriculata*, Forbes. There is this to be said, however: the respective figures of the two authors named do not strongly resemble one another; the present determination must therefore stand on the faith of Stoliczka's identification. In India the species is a member of the Arrialoor Group.

The sculpture in the S. African examples consists of very delicate linear costæ, and equally fine concentric lines, producing a microscopical decussation of the surface. The interiors around the ventral margins are toothed, but with the features of the area and articulus I am not acquainted.

GENUS CUCULLÆA, *Lamarck*, 1801.
(Syst. Anim. s. Vert., 1801, p. 116.)
CUCULLÆA (?) UMSINENENSIS, *sp. nov.*
(Pl. III., Figs. 3–4*a*.)

Sp. Char.—Shell (left valve) subquadrangular, inflated, rather oblique; cardinal margin straight, slightly less than the width of the valve; area narrow; articulus bearing numerous small cardinal teeth, and a few lateral transverse teeth; umbo nearly central, overhanging the area, the umbonal region in general tumid; posterior diagonal ridge rounded, but becoming more acute towards the umbo; posterior slope abrupt, steep, medianally longitudinally divided by a not very conspicuous obtuse fold, which slightly insinuates the posterior-ventral margin twice; anterior end becoming more and more compressed towards the anterior margin, which is rounded, below passing into the obliquely-rounded ventral margin.

* Griesbach, Quart. Journ. Geol. Soc., 1871, xxvii., p. 66, t. 3, f. 8, 8*a* and *b*.

Sculpture radio-concentric, but the radii very faint, and quite subordinate to the concentric lines, except on the immediate umbonal region.

Obs.—The articulus is not sufficiently well preserved to allow the nature of the lateral teeth to be fully determined; I therefore place the shell in *Cucullæa* provisionally only.

The posterior-ventral prolongation of the shell seen in *Arca capensis*, Griesbach,* does not exist to the same extent here; and neither in outline nor sculpture do *Latiarca* (?) *natalensis*, Baily, sp.,† or *Trigonarca umzambaniensis*, Baily, sp.,‡ agree with the present form. The latter is also separated from all three of the preceding by the presence of a fold on the posterior slope which fluctuates the posterior-ventral margin. In the nature of the sculpture *C. umsinenensis* is allied to *Trigonarca brahminica*, Forbes, sp.,§ and other similar forms.

GENUS TRIGONIA, *Bruquière*, 1789.
(Encycl. Méthod., 1789, t. xiv.)
TRIGONIA VENTRICOSA, *Krauss*, *sp.*
(Pl. I., Figs. 7 and 8.)

Lyrodon ventricosus, Krauss, Nova Acta Acad. Cæs. Leopol.-Carol. Nat. Cur., 1850, xxii., p. 456, t. 49, f. 2*a–f*.

Obs.—A single specimen of a small *Trigonia* is present in the Collection, that I cannot distinguish from the above species of the Uitenhage formation. It is so referred for the following reasons:—(1) the outline appears to correspond; (2) small number of the subradiating costæ; (3) faintly sigmoidal outline of these costæ; (4) tentency of the costæ to spread or enlarge towards the ventral margin; (5) closely crenulated sculpture of the costæ in the umbonal region, a feature distinguishable in Krauss's fig. 2*c*; (6) the comparatively wide intercostal spaces.

The specimen is an imperfect left valve, rotund-trigonal in outline, robust in habit, and if complete would be rostrate posteriorly. The posterior slope is medianally divided by a longitudinal groove, and dips suddenly over into a narrow escutcheon-like area; on the posterior slope are a number of oblique crenulated ridges, which do not correspond to the costæ in number, but are far more numerous. There are twelve costæ preserved, the anterior seven of which only radiate from the umbo. They are oblique, thick, slightly irregular in their course, and faintly sigmoidal, gradually enlarging towards the

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* Griesbach, Quart. Journ. Geol. Soc., 1871, xxvii., p. 66, t. 3, f. 10.
† Baily, Quart. Journ. Geol. Soc., 1855, xi., p. 460, t. 13, f. 2*a* and *b*.
‡ *Ibid.*, p. 460, t. 13, f. 1.
§ Forbes, Trans. Geol. Soc., vii. (2), t. 16, f. 1*a* and *b*.

ventral margin, steep on the anterior sides, and tailing-off on their posterior aspects. The dorsal portions of all these costæ, particularly in the umbonal region, are crossed by small, close, concentric crenulations, becoming fainter in the intercostal spaces; the ventral halves of the costæ have a roughened or sub-nodular appearance, and are crossed by ordinary concentric sculpture lines. The crenulations may possibly have extended over those on the body of the valve, but are now worn off.

I am in doubt whether or no *T. umkwelanensis*, mihi, may not prove to be this species also, but throughout the large number of specimens and fragments of the latter examined, I failed to notice one exhibiting any trace of the crenulated sculpture of the slightly sigmoidal costæ. The specimen on which my determination is made was certainly found in the present series of fossils when the collection was unpacked, but the matrix is so like that of the third series of organic remains (from Manuan Creek, Lebombo Range), still to be described, that I feel a mistake may have occurred in assigning it to the Umsinene River fauna. This suspicion is accentuated by the fact that the form is undoubtedly present in the parcel from the Lebombo Range.

A second *Trigonia* is represented in Pl. IV., Fig. 10, a very imperfect internal cast, with small portions of testiferous matter adhering. It reminds one very much of the internal casts of the more attenuate varieties of *T. aliformis*, Parkinson.* Of the South African *Trigoniæ*, so far described, this cast to some extent resembles *T. conocardiiformis*, Krauss,† but I think, had there been any relation, some trace of the characteristic sculpture of the latter would have been preserved.

Genus Protocardium, *Beyrich*, 1845.

(Zeit. Malakol., 1845, p. 17.)

Protocardium (?) cinctutum, *sp. nov.*

(Pl. III., Figs. 6 and 7.)

Sp. Char.—Shell (right valve) small, sub-rotund, sub-equilateral, moderately inflated; cardinal-margin shorter than the width of the valve; ventral margin well rounded; anterior margin rounded; posterior margin obliquely truncate; umbonal region inflated; anterior and posterior slopes steeply inclined, the diagonal ridge of the latter indicated by a continuous, linear, raised thread reposing in a groove, visible both on the outer surface of the test and on the internal cast, but more conspicuous on the latter; sculpture entirely concentric, of microscopic lines, the posterior slope being devoid of radii.

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* Lycett, Mon. Foss. Trigoniæ, No. iii., 1875, t. 25, f. 5.

† Krauss, Nova Acta Acad. Cæs. Leopol.-Carol. Nat. Cur., 1850, xxii., t. 49, f. 1*a–c*.

Obs.—This is a peculiar small shell, possibly referable to this genus, although I have not seen the dental characters, and the posterior slope is not radio-costate. Notwithstanding its small size, *P.* (?) *cinctutum* appears to be allied to the large *Cardium sphæroideum*, Forbes,* of the Lower Greensand. In this shell the sculpture of the posterior slopes is similarly concentric, and the slopes are divided from the remainder of the valves by diagonal impressed grooves. *C. sphæroideum*, Stoliczka says, "is apparently a *Lævicardium*, or" "like the next" (*Cardium Forbesi*, a *Protocardium*).† Another species, *C. imbricatarium*, D'Orb., has the form, again according to Stoliczka, "of a *Protocardium*, but apparently no radiating stride on the" "posterior declivity, though this is distinctly separated from the rest of" "the shell by an interior sulcus."‡ The appearance of the two shells cited is so manifestly that of *P.* (?) *cinctutum* that to whatever genus they belong, the latter will also be referable.

GENUS ASTARTE, *J. Sowerby*, 1816.
(Min. Conch. Gt. Brit., 1816, ii., p. 85.)
ASTARTE HERZOGII, *Krauss* (?).
(Pl. III., Fig. 8.)

Astarte Herzogii, Krauss, Nova Acta Acad. Cæs. Leopol.-Carol. Nat. Cur., 1850, xxii., p. 447, t. 47, f. 2*a-e*.

Sp. Char.—Shell (right valve) rounded, sub-trigonal, length and breadth almost equal, but the latter slightly the greater, moderately convex; cardinal margin much arched, declining rapidly on the posterior side; umbo slightly more anterior than median, elevated, pointed, and incurved; anterior margin concave above, well rounded medianally and below; lunule well defined, broad; posterior end not greatly produced, its margin descending rapidly from the umbo, and rounded below. Sculpture consisting of very regular, concentric rugæ, but without latilaminæ; those on the umbonal region fine and linear, the remainder increasing in width downwards.

Obs.—In the absence of articular details it is impossible to decide between *Astarte*, J. Sby., and *Eriphyla*, Gabb, but the outline is so characteristically that of Sowerby's type, *A. lurida*,§ and its associated species, *A. elegans* and *A. cuneata*, particularly the latter, that I consider it better to retain the shell in *Astarte* provisionally until the details of the articulus are known.

Astarte Herzogii, Goldfuss,‖ and the shell figured by Krauss

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* Forbes, Quart. Journ. Geol. Soc., 1845, i., p. 243, t. 2, f. 8.
† Stoliczka, Cretaceous Fauna S. India (Pal. Ind.), iii. (Pelecypoda), p. 213.
‡ *Ibid.*, p. 213.
§ Sowerby, Min. Conch. Gt. Brit., 1816, ii., t. 137, f. 1.
‖ Goldfuss, Petrefacta Germaniæ, t. 149, f. 10*b*.

under the same name, differ very greatly in the tumidity of the valves, so much so that it is difficult to conceive them to be the same species; the lunule of the former is also much wider and rounder than that of the latter. I believe the present *Astarte* to be Krauss's shell in preference to that of Goldfuss, and have accordingly appended the former's name to it, leaving the solution of the difficulty to those possessing actual specimens from the Uitenhage beds. The Umsinene valve possesses an entirely different outline to that of *A. pinchiniana*, Tate,* or the large *A. longlandsiana*, Tate.† I have experienced difficulty in finding published figures for comparison with this shell, but *A. impolita*, J. de C. Sby.,‡ of the Blackdown Upper Greensand, appears to be its nearest ally.

GENUS VENIELLA, *Stoliczka*,§ 1870.

(Cretaceous Fauna S. India (Pal. Ind.), iii., Pelecypoda, 1870, p. 189.)

VENIELLA (?) SANCTÆ-LUCIENSIS, *sp. nov.*

(Pl. III., Figs. 1 and 2.)

Sp. Char.—Shell (right valves) ovate-quadrangular, tumid, the surface regularly convex between the anterior and posterior slopes; cardinal margin arched; umbo incurved; ventral margin evenly rounded; anterior end produced antero-ventrally; anterior slope curved from above downwards, abruptly separated from the general surface, but without a defined diagonal ridge, the margin sinuous under the umbo, but rounded and swelling out below; a sharp posterior diagonal ridge; posterior slope steeply inclined; posterior margin truncate and oblique. Sculpture concentric, with strong latilaminæ, having abrupt lower terminal edges.

Obs.—*V.* (?) *sanctæ-luciensis* was provided with deep latilaminæ having abrupt lower terminal edges. The anterior end, below the lunule, does not project laterally to the same extent as in some Arcticas—*e.g.*, *A.* (*Venilicardia*) *bifida*, Zittel,‖ and the downward sweep of the curved umbonal ridge is longer and more open than in many species of that genus. In this feature our imperfect specimen resembles the Blackdown Lower Greensand *Arctica rostrata*, J. de C. Sby.¶ It is quite distinct from the group of shells in the Cretaceous of Southern India represented by *A.* (*Veniella*) *forbesiana*, Stoliczka,** with its strong diagonal ridge. The deeply insinuated anterior end

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* Tate, Quart. Journ. Geol. Soc., 1867, xxiii., t. 9, f. 7*a*. † *Ibid.*, t. 8, f. 5*a*.

‡ Sowerby, Trans. Geol. Soc., 1836, iv. (2), Pt. 2, t. 16, f. 18.

§ *Non Venilia*, Morton, *nec* Alder and Handcock.

‖ Zittel, Bivalven Gosaugibilde, 1 Theil, 1864, t. 5, f. 1*a*.

¶ Sowerby, Trans. Geol. Soc., 1836, iv. (2), Pt. 2, t. 17, f. 1.

** Stoliczka, Cretaceous Fauna S. India (Pal. Ind.), iii., Pelecypoda, 1870, t. 9, f. 4–6.

is again met with in *Arctica rugulosa*, Sharpe,* of the Sunday River beds, but our form is so very much larger and more massive, unless the former is a young individual.

This fossil is only provisionally referred to *Veniella*, as the nature of the articulus is unknown. In outline it is not a typical *Arctica*, but approaches that of *Veniella Conradi*, the type of Morton's genus *Venilia*, and Stoliczka's *Veniella*.† If referable to the latter, it is certainly distinct from the Indian Trichinopoly *V. forbesiana*, Stoliczka.‡ On the other hand, as a matter of mere outline, it is far more like *Arctica crassidentata*, Zittel,§ of the Gosau Cretaceous, which Stoliczka placed in his genus *Venilicardia*.

GENUS CYTHEREA, *Lamarck*, 1806.
(Ann. Mus. Paris, 1806, vii., p. 132.)
CYTHEREA (?), *sp.*
(Pl. III., Fig. 5.)

Obs.—Several specimens in the usual unsatisfactory state of preservation I am unable to refer to any genus except *Cytherea*, and to that only provisionally. The valves are markedly convex, the umbos large and prominent, and beneath them the anterior dorsal outline is deeply excavate; the sculpture is wholly concentric, fine, and regular. It is distinct from *C.* (?) *Kaffraria*, mihi.

GENUS PLEUROMYA, *L. Agassiz*, 1845.
(Études Crit. Moll. Foss., Liv. 4, 1845, p. 231.)
PLEUROMYA (?), *sp.*
(Pl. III., Fig. 10.)

Obs.—Two right valves may be referred provisionally to this very unsatisfactory genus. The valves, neither of which is perfect, are moderately transversely elongated, with straight cardinal margins, depressed or flattened umbos, with the immediate beaks, or apices, pressed against the cardinal margins, and directed anteriorly. The test is thin, with strong, finely lined concentric corrugations, the finer lines becoming roughened and irregular on the posterior end. If a *Pleuromya*, the pallial sinuses must have been very delicately impressed on the interiors of the shells, as I cannot trace them on a cast. The fossils are hardly worth notice were it not as an indication that a shell

* Sharpe, Trans. Geol. Soc., 1856, vii. (2), Pt. 4, t. 22, f. 9.
† Meek, Report U.S. Geol. Survey Territories (Hayden's), 1876, ix., p. 148, f. 9.
‡ Stoliczka, Cretaceous Fauna S. India (Pal. Ind.), iii., Pelecypoda, 1870, t. 9, f. 4–6.
§ Zittel, Bivalven Gosaugibilde, 1 Theil, 1864, t. 5, f. 2*a*.

of this nature occurs in the Umsinene deposit, and that it is quite distinct from *P.* (*Myacites*) *Bainii*, Sharpe,* of the Uitenhage formation.

GENUS MYOPSIS, *L. Agassiz*, 1842.
(Études Crit. Moll. Foss., Liv. 3, 1842, p. 251.)
MYOPSIS (?) AFRICANA, *sp. nov.*
(Pl. I., Figs. 9 and 10.)

Sp. Char.—Shell (left valve) transversely oblong, narrowing slightly towards the posterior; cardinal margin very slightly arched; ventral margin rounded, without insinuation or constriction; umbonal region moderately convex; umbo placed in advance of the middle, depressed, flattened from above, and anteriorly incurved; anterior end comparatively small, subdivided by an obtuse diagonal ridge, the surface from thence to the short, rounded margin becoming steep-walled; sub-umbonal area (false lunule) rather deeply excavated; posterior end occupying more than half the valve surface, the convexity gradually lessening to the rather obliquely rounded posterior margin; no appreciable diagonal ridge. Sculpture concentric, with profuse granulation, the granules arranged in radiating lines from the umbo, but apparently less developed on the extreme posterior.

Obs.—Agassiz speaks of a cardinal tooth in each valve of *Myopsis*, but I have not succeeded in disentangling the articulus of this shell from the matrix. *Myopsis* also gaped at both ends; *M. africana* certainly did so at the posterior end at least. Agassiz also laid stress on the radiating lines of granules, which, in the present instance, are very apparent. There is no inflection in the anterior ventral margin, as in many of the species originally referred to the genus by its describer. So far as outline only is concerned, this valve might be referred to *Pleuromya*, some species of which it resembles, but in the absence of more definite characters I have been guided by the sculpture.

Myopsis (?) *africana* is most nearly allied to *M. neocomensis*, L. Ag.,† and *M. unioides*, L. Ag.,‡ from the Lower Neocomian of Europe.

GENUS GLYCIMERIS (*Klein*), *Lamarck*, 1799.
(Mém. Soc. Hist. Nat. Paris, 1799, p. 83.)
GLYCIMERIS (?) GRIESBACHI, *sp. nov.*
(Pl. III., Fig. 9.)

Sp. Char.—Shell (right valve) transversely oblong-oval, moderately convex; cardinal margin gently convex on the anterior side, and

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* Sharpe, Trans. Geol. Soc., 1856, vii. (2), t. 22, f. 7*a* and *b*.
† Agassiz, Études Crit. Moll. Foss., Liv. 3, 1842, t. 31, f. 6. ‡ *Ibid.*, t. 31, f. 11.

similarly concave posterior to the umbo; valves gaping at both ends; umbo placed at rather less than the anterior third, obtuse, depressed, and flattened from above; anterior end sloping gradually from the umbonal region outwards, becoming flattened near the margin, which is rounded; posterior end long, comprising more than two-thirds the length of the valve, with a faintly defined, obtuse diagonal ridge, between which and the dorsal margin the surface is straight-walled; posterior margin (by lines of growth) rounded, dilated. Sculpture concentric, consisting of wide latilaminæ defined by grooves, with delicate interlining between.

Obs.—There are several examples of this form, partly testaceous, partly internal casts, but on the latter the adductor scars are not visible. *G.* (?) *Griesbachi* is allied to *G. elatior*, D'Orb.,* of the French Chloritic Chalk. It is a much longer and more slender shell than either the *Myacites* (?) *Bainii*, Sharpe,† of the Sunday River Uitenhage beds, or *G.* (*Anoplomya*) *lutraria*, Krauss.‡ I may remark in passing that some doubt appears to exist as to what *Anoplomya* really is, for G. W. Tryon, Junr.,§ places it as a synonym, both of *Pleuromya*, L. Ag., and *Chænomya*, Meek and Hayden.

Named in honour of Mr. C. L. Griesbach.

GENUS PARAPHOLAS, *Conrad*, 1848.

(Proc. Acad. Nat. Sci., Philadel., 1848, p. 121.)

PARAPHOLAS TATEI, *sp. nov.*

(Pl. IV., Figs. 6–7*a*.)

Sp. Char.—Shell (right valve) apparently transversely oblong; dorsal margin straight as far as preserved; posterior dorsal portion appears to be marked off by a well-defined depression; general surface gently convex; umbonal cincture pronounced, consisting of a groove, and rib immediately posterior to it, traversing the valve obliquely so as to intersect the ventral margin.

The groove transversely crenulated; anterior to and removed from this umbonal cincture is a second plain groove (in the cast) proceeding at a much more oblique angle from the dorso-anterior margin, and approaching the ventral margin just in front of the umbonal cincture. Sculpture on the posterior end concentric, the anterior ornamentation not preserved.

Obs.—All that remains of this most interesting form consists of the median portion of one valve; the extreme anterior end is hidden

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* D'Orbigny, Pal. Franç. Terr. Crét., 184 (Lamellibr.), t. 361, f. 3 and 4.

† Sharpe, Trans. Geol. Soc., 1856, vii. (2), t. 22, f. 7*a* and *b* (= *Pleuromya*, Newton, Journ. Conch., 1896, viii., No. 5, p. 150).

‡ Krauss, Nova Acta Acad. Cæs. Leopol.-Carol. Nat. Cur., 1850, xxii., t. 47, f. 1*a–b* (= *Pleuromya*, Newton, *loc. cit.*, p. 151).

§ Tryon, Structural and Syst. Conchol., 1884, iii., pp. 148 and 151.

by matrix, and most of the posterior end has been removed by fracture; nevertheless I believe sufficient remains to indicate its generic position. No trace of any accessory plates remains, but the umbonal furrow, or cincture, is remarkably plain, and the second or anterior furrow, visible in this cast condition, is quite discernible. In the present fragmentary state, immediately below the posterior dorsal margin is a small flattened surface, cut off by a declivity or slope, but too great stress cannot be laid on this until more is known about it.

This fragmentary specimen cannot be referred to *Martesia*, Leach, in consequence of possessing two diagonal grooves or cinctures. It is not a *Turnus*, Gabb,* because the supplementary cincture is situated on the anterior instead of the posterior side of the umbonal cincture, and the same feature also separates it from the associated genera *Goniochasma*, Meek,† and *Xylophazella*, Meek.‡ It is, however, to those of *Parapholas*, Conrad, that the double oblique cinctures appear to correspond in position. In *P. californica*, Conrad, the type, there is a not very oblique umbonal cincture, and a very oblique anterior one, our small fossil differing simply in the fact that the anterior cincture is less oblique than that of *P. californica*.

On the same piece of matrix, and quite contiguous to this specimen, is a small exfoliated shell (Pl. IV., Fig. 6*a*), possibly identical, as it possesses an oblique umbonal groove; it is, however, too imperfect to place much reliance on. It lies at the fractured end of a tube, but whether any relation exists between the latter and the shell it is impossible to say.

If my conception of this fossil be the correct one, it is neither *Parapholas mersa*, Stoliczka,§ of the Indian Ootatoor Group, nor *P. sphenoideus*, White,‖ from the Cretaceous strata of Southern Utah.

In Mr. R. B. Newton's list¶ of South African Mesozoic fossils, no member of the Pholadidæ is recorded.

Named in honour of the late Professor Ralph Tate, of Adelaide, South Australia.

Teredo (?) Tubes.

(Pl. V., Fig. 13.)

Obs.—In Mr. R. B. Newton's list of South African Mollusca fossils** no member of the Teredidæ is recorded from deposits of Cretaceous age, but Griesbach†† mentions *Teredo* borings in wood

* Gabb, Report Geol. Survey California, Pal. I., 1864, p. 145.

† Meek, Report U.S. Geol. Survey Territories (Hayden's), 1876, ix., p. 255.

‡ *Ibid.*

§ Stoliczka, Cret. Fauna S. India (Pal. Ind.), iii., Pelecypoda, 1870, t. 2, f. 7, 7*a–c*.

‖ White, Hayden's 11th Ann. Report U.S. Geol. and Geogr. Survey Territories (Idaho and Wyoming), 1879, p. 300, t. 5, f. 1*a–d*.

¶ Newton, Journ. Conch., 1896, viii., No. 5, pp. 148–151.

** *Ibid.*

†† Griesbach, Quart. Journ. Geol. Soc., 1871, xxvii., pp. 62 and 68.

in his Izinhluzabalunga beds. Fragments of wood occur here and there amongst our fossils, in one instance (Pl. V., Fig. 13) traversed by short curving tubes of variable diameter that may possibly be referable here, although, judging by White's remarks on his *Parapholas sphenoideus*, referred to on a previous page, it is possible these tubes may be the work of *P. Tatei.*

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4. GASTEROPODA.

GENUS ACT.EON, *De Montfort*, 1810.

(Conch. Syst., 1810, ii., p. 315.)

ACTÆON, *sp.*

(Pl. IV., Figs. 11 and 12.)

Obs.—We possess a single specimen in all probability referable to this genus. It consists of the body and portion of the penultimate whorl, with the oral margins broken away. It cannot be asserted with certainty of what nature the columella fold or folds were. The rapid diminution of the spiral angle, represented by the difference in size of the two whorls, indicates that the length of the shell was not great. The sculpture is beautifully punctate-grooved, the grooves very numerous and regular, extending over the whole of the whorls. The punctæ are close together, and the interspaces between the grooves of equal width.

It is neither *Actæon Atherstoni*, Sharpe,* *Actæonina Sharpeana*, Tate,† *A. Morrisiana*, Tate,‡ nor *A. Jenkinsiana*, Tate,§ all of the Uitenhage formation. Although the outline is very similar to that of the little shell I termed *Actæonina Atherstoni*, var. *umkwelanensis*,‖ the present form is a much more robust one, and the sculpture extends over the entire surface of the whorls.

GENUS ZARIA, *Gray*, 1840.

(Synop. Brit. Mus., 1840 (?); *Id.*, ed. 1841, p. 125; Proc. Zool. Soc., 1847, Pt. 15, p. 155.)

ZARIA (?), *sp.*

(Pl. V., Figs. 4 and 5.)

Obs.—Portions of two shells, the apices and body whorls, and perhaps others above the latter wanting, appear to belong to some member of the *Turritellidæ*. Each whorl is ornamented with re-

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* Sharpe, Trans. Geol. Soc., 1856, vii. (2), p. 200, t. 28, f. 19.
† Tate, Quart. Journ. Geol. Soc., 1867, xxiii., p. 154.
‡ *Ibid.*, p. 153. § *Ibid.*, p. 154.
‖ Etheridge, this Memoir, Pt. i., 1904, p. 87, t. 2, f. 38.

volving fine threadlets, and very much stronger threads bearing numerous small nodules; there are three chief threads on each whorl, and a subsidiary one below each suture. There is very little distinction between the whorls beyond the impressed lines of the sutures, and in consequence the re-entrant angles are equally ill-defined.

The specimens are not sufficiently perfect for determinative purposes, but they seem to be allied to such species as *Turritella* (?) *nerinea* (Roemer), Stoliczka,* or *T. nodosa* (Roemer), Stoliczka,† both of the Indian Ootatoor Group. They are quite distinct from the Uitenhage *T. Rubidgeana*, Tate,‡ which also has some of the revolving threads tuberculated.

GENUS SOLARIUM, *Lamarck*, 1799.
(Mém. Soc. Hist. Nat. Paris, 1799, p. 74.)
SOLARIUM HEDLEYI, *sp. nov.*
(Pl. V., Figs. 10-12.)

Sp. Char.—Shell small, orbicular, apparently of six whorls; spire but little elevated; whorls on their anterior and larger portions gently convex, thence flat or concave, suddenly becoming straight-walled to form an obtuse bourrelet; base slightly rounded or convex to the umbilical margin, which is rounded off, and the umbilicus small. Sculpture on the convex portion of the body and penultimate whorls consisting of about five revolving lines of granules, separated by simple revolving threads; on the flat or concave portion are lines of smaller granules, with a single coarser series immediately along the edges of the bourrelets, and, on the straight-walled faces of the latter, fine vertical close-granulated costæ; on the base are revolving lines of simple granules, becoming coarser towards the umbilicus, the edge of which is defined by a circle of granules larger than any of the others; the whole crossed by delicate, fine growth lines, oblique on the whorls above and concave towards the inner lip on the base.

Obs.—This beautifully sculptured little shell is quite distinct from both *S. Wiebeli*, Griesbach,§ and *S. pulchellum*, Baily,‖ but of the two it is more nearly allied to the latter than the former. It is equally distinct from the four Arrialoor species described by Stoliczka. It possesses a more elevated spire than that of the *Solarium* figured from the Umkwelane Hill deposits, and the sculpture is far more ornate than that of the latter, which appears to be simply decussate.

Named in honour of my colleague, Mr. Charles Hedley, of the Australian Museum, to whom I am indebted for many conchological hints.

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* Stoliczka, Cret. Fauna S. India (Pal. Ind.), ii., 1868, p. 222, t. 19, f. 18, 19.
† *Ibid.*, f. 20, 21.
‡ Tate, Quart. Journ. Geol. Soc., 1867, xxiii., p. 152, t. 8, f. 6*a* and *b*.
§ Griesbach, Quart. Journ. Geol. Soc., 1870, xxvii., t. 3, f. 6, 6*a* and *b*
‖ Baily, Quart. Journ. Geol. Soc., 1855, xi., t. 12, f. 3*a* and *b*.

GENUS PSEUDAMAURA, *Fischer*, 1885.

(Man. Conch. et Pal. Conch., Fas. 8, 1885, p. 767.)

PSEUDAMAURA TERRAZULENSIS, *sp. nov.*

(Pl. IV., Figs. 3–5; Pl. V., Figs. 6–8.)

Sp. Char.—Shell naticiform, of from four to five whorls; body whorl somewhat inflated and rounded, without a sutural shoulder, neither carinate nor angulated; whorls close, without channelled sutures, and the difference in inflation between the anterior whorls and the body whorl very marked. Aperture irregularly ovate, broader below than above; outer lip describing an unsymmetrical oval curve; inner lip faintly sigmoidal, thickened and reflected, the reflection channelled. Sculpture of flat riblets following the curvature of the outer lip, those contiguous to the latter the broadest, but rapidly becoming finer as the lip is receded from; each riblet is crossed by very fine, transverse, upwardly curved grooves, producing a delicate festoon-like decussation, less apparent near the outer lip than on other portions of the shell.

Obs.—I must confess to great perplexity in dealing with the generic position of this imperfect naticiform shell—*Ampullina*, *Amauropsis*, *Pseudamaura*, and perhaps also *Neridomus*, as interpreted by Böhm,* all putting in a claim for recognition—but following a former determination† of my own, I tentatively adopt *Pseudamaura*.

Stoliczka figured a naticiform shell from the Indian Ootatoor Group as *Euspira spissata*,‡ with a similarly, although less channelled inner lip, but differing in all other features.

Pseudamaura terrazulensis to some extent resembles *Natica multistriata*, Baily, in its delicate reticulate sculpture, but the latter certainly possesses a more attenuated spire and a less gibbous body whorl. Shells bearing a somewhat similar sculpture, from the Upper Cretaceous of Baluchistan, are referred by Dr. F. Noetling to *Nerita*,§ but very little appears to be known of the characters of the aperture.

GENUS ALARIA, *Morris and Lycett*, 1850.

(Mon. Moll. Gt. Oolite, Pt. 1, 1850, p. 15.)

ALARIA (?) BAILYI, *Eth. fil.*

(Pl. V., Fig. 9.)

Alaria (?) *Bailyi*, Eth. fil., this Memoir, Pt. 1, 1904, p. 83, t. 3, f. 4–8*a*.

Obs.—Two young examples of this Umkwelane Hill species are present in the collection. One is only the pupa-like four posterior

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* Böhm, Zeitsch. Deuts. Geol. Gesellsch., 1900, lii., 2 Heft, p. 190.

† Etheridge, Mem. Geol. Survey N.S. Wales, Pal. xi., 1902, p. 40.

‡ Stoliczka, Cret. Fauna S. India (Pal. Ind.), ii., Gastropoda, 1868, t. 22, f. 3.

§ Noetling, Fauna of Beluchistan (Pal. Ind.), i., Pt. 3, 1897, pp. 54–55.

whorls, with the sculpture removed by exfoliation. The second and larger example consists of six small whorls, and although more mature than the other, is still a young shell. The first two whorls are devoid of sculpture, the third, fourth, and fifth are both costate and delicately spirally lined, and the sixth is the exfoliated body whorl, with its anterior portion seen in section and prolonged into a slender canal.

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5. CEPHALOPODA.

GENUS DOUVILLEICERAS, *Grossouvre.*

(Rech. Craie Sup., Pt. 2, Pal., 1893, p. 26.)

DOUVILLEICERAS (?) NODOSA, *sp. nov.*

(Pl. IV., Figs. 1 and 2.)

Obs.—A number of fragmentary specimens are believed to be referable to this genus. The most complete example is a portion of a whorl with a broad rounded venter and gently convex flanks. Ten thick, obtuse, slightly flexuous costæ are preserved, decorated with seven rows of longitudinally elongated blunt tubercles. One row occupies the centre of the venter, bordered on each side by one at the abdominal angles; on each flank there are two rows, one immediately below the angle and the other slightly removed therefrom, but still not overhanging the umbilical cavity. The intercostal spaces are concave, groove-like, and smooth, and broader on each side towards the venter. The tubercles are not spine-bearing, and the costæ do not bifurcate, neither are there interpolated costæ. In this specimen the rows of tubercles appear to be rather few in number for a species of this genus, but on a fragment of a larger whorl the number of rows is largely increased, presuming the two to be one and the same. There is no keel, as in the allied genus *Mortoniceras*, Meek.

D. nodosa bears a closer resemblance to *D. Lyelli*, Leymerie,* than it does to *D. mammillaris*, Schlotheim; † it possesses similar tubercles to those of the former, and like well-developed costæ of the latter.

These fragments also bear some resemblance to certain South Indian Cretaceous species of *Acanthoceras, e.g., A. Turneri*, White,‡ and *A. Newboldi*, Kosmat.§

Two other specimens, one of which is figured (Pl. V., Figs. 1 and 2), differ very widely from the above in that the costæ are much more numerous, often bifurcate immediately round the umbilical edges, and are armed with very many rows of tubercles, the numbers far in excess of those to which I have applied the name of *D. nodosa.* Whether these are specifically distinct from, or are portions of, whorls of a different age, I am not in a position to decide.

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* D'Orbigny, Pal. Franç. Terr. Crét., I., Cephalopoda, 1841, p. 255, t. 74.

† *Ibid.*, t. 73.

‡ Kosmat, Beitrage Pal. Geol. Österreich-Ungarns, xi., 1 Heft, 1897, t. 1, f. 1*a*.

§ *Ibid.*, t. 1, f. 2*b*.

GENUS DESMOCERAS, *Zittel*, 1884.

(Handb. Pal., 1 Abth., Palæozoologie, ii., 1884, p. 465.)

DESMOCERAS, *sp.*

(Pl. VI.)

Obs.—The presence of still another Ammonite in the Natal Cretaceous is indicated by a portion of a large exfoliated shell, which is quite distinct from any of those described by Messrs. Sharpe, Baily, Griesbach, or Tate. The specimen is half an individual measuring along the fractured edges ten inches, and in transverse diameter six and a quarter inches.

The venter is broadly rounded, the flanks very gently convex, with indications of slightly rounded and sigmoidal costæ, finer rather than coarse for the size of the shell; on the venter these are very faintly concave, from before backwards. Two varicial and sigmoidal constrictions are preserved, the bounding costæ on the flanks being bolder than any of the others; the ventral apices of these constrictions are shallow and inconspicuous.

I refer this fossil to *Desmoceras* with reservation, although from the few characters decipherable it appears to appertain to that genus. It is possibly allied to the Gault *D. mayorianum*, D'Orb.,* and, like it, possesses a broad venter, and also to the Ootatoor form of *D. Beudanti*, Brongniart.†

GENUS HAMITES, *Parkinson*, 1811.

(Organic Remains, 1811, iii., p. 144.)

HAMITES (?), *sp.*

(Pl. V., Fig. 3.)

Obs.—A small portion of an uncoiled shell is represented in Pl. V., Fig. 3. It is remarkable for its pronounced, thin, upstanding costæ, and very wide, concave intercostal spaces. *Hamites africanus*, Tate,‡ possesses prominent costæ, but they are much more oblique than those of this specimen. On the dorsum the costæ appear to lose their erect character and to dwindle to mere superficial ridges. The reference to *Hamites* can only be regarded as provisional.

The transverse section is a broad oval, not ellipsoidal, nor are the sides compressed, nor is the dorsum acute, with the costæ meeting in the middle line at an acute angle, as in *H. africanus*.

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* D'Orbigny, Pal. Franç. Terr. Crét., I. Cephalopoda, 1841, t. 79.

† Stoliczka, Foss. Cephalopoda Cret. Rocks S. India (Pal. Ind.), Pt. 8, 1865, t. 71, f. 3, 3*a*.

‡ Tate, Quart. Journ. Geol. Soc., 1867, xxiii., t. 7, f. 5*b*.

III.—GEOLOGICAL RESULTS.

In the Umsinene River Calcareo-argillaceous bed the Pelecypoda predominate greatly over both the Gasteropoda and Cephalopoda. The number of species of all kinds recognisable now, or sufficiently well indicated to be specifically determinable on the acquisition of better material in the future, is as follows :—

Annelida	1
Echinodermata	1
Pelecypoda	17
Gasteropoda	5
Cephalopoda	3
	27

Only one species can be said to be actually identical with the Umkwelane Hill fauna, viz., *Alaria* (?) *Bailyi*, Eth. fil., but as the general facies of the Umsinene fossils resembles that of the Umkwelane Hill bed, I am induced to regard them simply as horizons in one and the same geological series.

If my determinations of these very fragmentary fossils are correct, we find in the Umsinene bed four Uitenhage forms, viz. : *Serpula pinchiniana*, Tate, *Gervillia dentata*, Krauss, *Trigonia ventricosa*, Krauss, and *Astarte Herzogii*, Krauss.

The Cephalopoda are again few in number, and as in the case of the Umkwelane Hill fauna there is an entire absence of those species recorded from his Umtafuna fauna by Griesbach.

TABLE A.

Species, occurring elsewhere, allied to certain of those described in this paper.

Umsinene River Species.	Allied Species.	Horizon.
Neithea quinquecostata, *J. Sby.*	N. quinquecostata (*J. Sby.*), *Stol.*	Ootatoor, Trichinopoli, and Arrialoor Groups, India.
Entolium Andersoni, *Eth. fil.*	Pecten (Syncyclonema) obovatus, *Stol.*	Ootatoor Group, India.
Pseudavicula (?) Africana, *Eth. fil.*	Pseudaviculæ.	Rolling Downs Formation, Q'land.
	Pseudomonotis (?) inops, *Stol.*	Arrialoor Group, India.
Gervillia dentata, *Krauss.*	G. aviculoides, *J. de C. Sby.*	Neocomian, Europe.
	G. anceps, *D'Orb.*	
Protocardium (?) cinctutum, *Eth. fil.*	Cardium sphæroideum, *Forbes.*	" "
Veniella (?) sanctæ-luciensis, *Eth. fil.*	Arctica rostrata, *J. de C. Sby.*	Blackdown Greensand (Upper Cretaceous).
Myopsis (?) africana, *Eth. fil.*	M. neocomensis, *L. Ag.*	Neocomian, Europe.
	M. unioides, *L. Ag.*	
Glycimeris (?) Griesbachi, *Eth. fil.*	G. elatior, *D'Orb.*	Chloritic Chalk (Upper Cretaceous).
Zaria, *sp.*	Turritella (?) nerinea (*Roemer*), *Stol.*	Ootatoor Group, India.
	Turritella (?) nodosa (*Roemer*), *Stol.*	
Douvilleiceras (?) nodosa, *Eth. fil.*	D. Lyelli, *Leymerie.*	Gault (Upper Cretaceous), Europe.

TABLE B.

Principal species believed to be identical with, or closely related to, already described South African forms.

Umsinene River Species.	Already Described South African Species.	Horizon.
Hemiaster (?), *sp.*	H. Forbesi, *Baily.*	Umtafuna Beds.
Serpula pinchiniana, *var.* umsinenensis, *Eth. fil.*	S. pinchiniana, *Tate.*	Uitenhage Formation.
Neithea quinquecostata, *J. Sby.*	N. quinquecostata (*J. Sby.*), *Baily.*	Umtafuna Beds.
Gervillia dentata, *Krauss.*	G. dentata, *Krauss.*	Uitenhage Formation.
Cucullæa (?) umsinenensis, *Eth. fil.*	Arca capensis, *Griesbach.*	Umtafuna Beds.
Trigonia ventricosa, *Krauss.*	T. ventricosa, *Krauss.*	Uitenhage Formation.
Astarte Herzogii, *Krauss.*	A. Herzogii, *Krauss.*	,, ,,
Actæon, *sp.*	A. Atherstoni, *var.* umkwelanensis, *Eth. fil.*	Umkwelane Hill Bed.
Pseudamaura terrazulensis, *Eth. fil.*	Natica multistriata, *Baily.*	Umtafuna Beds.
Alaria (?) Bailyi, *Eth. fil.*	A. (?) Bailyi, *Eth. fil.*	Umkwelane Hill Bed.

REPTILIAN FOSSIL REMAINS FROM NATAL.

PART I.—ON REPTILIAN REMAINS FROM THE SUPPOSED BEAUFORT BEDS OF THE UMKOMAZAN RIVER, WESTERN NATAL.

PART II.—ON SOME REPTILIAN REMAINS FROM THE CRETACEOUS BEDS AT THE MOUTH OF THE UMPENYATI RIVER.

BY R. BROOM, ESQ., M.D., D.SC., C.M.Z.S.

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ON SOME REPTILIAN FOSSIL REMAINS FROM NATAL,

BY

R. BROOM, M.D., D.Sc., C.M.Z.S.

I.—ON REPTILIAN REMAINS FROM THE SUPPOSED BEAUFORT BEDS OF THE UMKOMAZAN RIVER IN WESTERN NATAL.

The bones forming this collection are for the most part fragmentary, and are apparently from various * localities; while in Cape Colony the reptilian bones are usually found in groups representing at least portions of skeletons, in Natal most of the bones appear to have been found isolated.

As almost all the Beaufort reptiles have been described from skulls or portions of skulls, and as the post-cranial skeletons of very few types are as yet known, it is impossible at present to determine limb bones with any degree of certainty. I shall therefore confine my remarks to those specimens on which a definite opinion can be given.

Lystrosaurus Andersoni, *sp. nov.*

The best preserved specimen in the collection is the greater portion of the skull of a large species of *Lystrosaurus*. The genus *Lystrosaurus*, Cope. (= *Ptychognathus*, Owen, and in part *Ptychosiagum*, Lyd.) was founded on a small species, *L. frontosus*, of which only one specimen is known. It seems advisable, however, to include under the name, all Owen's species of *Ptychognathus* and the large forms described by Seeley, *L. McCaigi* and *L. platyceps*. The species described by Owen form a group by themselves, and Seeley's two large species form a second group. It is to this latter group that the Natal species belongs.

It is slightly larger than *L. platyceps*, but considerably smaller than *L. McCaigi*. The eyes are large and have a well-developed upwardly directed supra-orbital margin. The prefrontal-nasal region is broader and flatter than in either *L. platyceps* or *L. McCaigi*. Near the middle line in the upper part of the nasal bones are a pair of elongated depressions which are continued down at least to the lower part of the

* All the specimens were taken from the same outcrop of shales within a quarter of a mile radius.—W. A.

nasal bones. On the upper part of each prefrontal is another depression, deeper and narrower than in *L. McCaigi*. Between the prefrontal and nasal depressions is a well-marked ridge, but it does not form a prominent process as in *L. McCaigi*. The frontal region makes with the nasal, an angle of about 90°. It is concave, and, as in *L. platyceps*, quite devoid of the median process seen in *L. McCaigi*.

The following are some of the principal measurements of the skull :—

Width of prefrontal region	about 110 mm.
Width of supra-orbital region ..	about 60 mm.
Vertical diameter of orbit	about 80 mm.
Distance between the tusks	about 70 mm.
Tusk near margin of jaw measures	17 mm. × 14 mm.

I have named the species after Mr. William Anderson, of the Natal Geological Survey.

There are in addition a very imperfect mandible of a *Lystrosaurus* which may belong to *L. Andersoni*, and two imperfect portions of a maxilla which may also belong to the same species.

Lystrosaurus, *sp.*

A portion of a maxilla belongs to a small species of *Lystrosaurus* which may be new, but the fragment is too imperfect to admit of exact determination. There is also an exoccipital bone of perhaps the same small *Lystrosaurus*.

Dicynodon, *sp.*

In the collection is a specimen of the front portion of the skull of a large *Dicynodon*, and a fragment of the right maxilla of a second specimen. This species is possibly new, but owing to the variability of *Dicynodon* it seems better not to propose a new name till more of the skull is discovered. Of described species it comes nearest to *D. latifrons*, but is much larger than the type. The tusk is directed forwards in a line parallel with the upper surface of the snout. Where it leaves the maxilla it measures 26 mm. and is quite round. The upper end of the tusk measures 30 mm. in diameter. On the outer side of the tusk the maxilla is thickened into a rounded ridge, as in various species of *Dicynodon*. The premaxillæ form a narrow beak, the lower part of which is at right angles to the tusk and passes upwards from the end of the maxilla. From the lower side of the tusk to the upper side of the snout measures 120 mm.

There are two limb bones —a portion of a femur and a tibia which probably belong to this species of *Dicynodon*.

Age of Beds.

Though the collection contains so few specimens there can be little doubt about the horizon of the Beaufort Beds to which they belong. In Cape Colony the Beaufort Beds have been divided into

(1) Lower beds, characterised by the presence of *Pareiasaurus*, *Oudenodon*, *Endothiodon*, *Dicynodon*, and *Therocephalians;* (2) Middle beds, characterised mainly by *Lystrosaurus;* and (3) Upper beds with *Dicynodon*, *Cynodonts*, *Procolophon*, *Howesia*, &c. The Natal *Lystrosaurs* are very similar to those of Cape Colony, while the *Dicynodon* comes nearest to the *Dicynodons* of the Upper Beaufort Beds. As there are no remains of *Cynodonts* or other typical forms of the Upper Beaufort Beds, it seems probable that the Natal beds correspond to the Middle Beaufort of Cape Colony.

II.—ON SOME REPTILIAN REMAINS FROM THE CRETACEOUS BEDS, AT THE MOUTH OF THE UMPENYATI RIVER.

The remains are for the most part very fragmentary and very much weathered, so that it is impossible to do more than refer them to the groups to which they belong. The most noteworthy specimens are the remains of a large Pythonomorph. There are two fragments of jaws with the sockets of teeth. While these are much too imperfect to determine with certainty, it seems probable that they belong to a species of *Liodon.* The largest fragment contains parts of the roots of five teeth, which are estimated to have occupied a space of about 200 mm. The fragments of limbs are too imperfect to be of any assistance in arriving at a more definite determination of the form.

Most of the other remains are those of Chelonians. There are portions of plastra, of rib-plates, and of marginal plates which seem to belong to two different species—a large and a small—of the Chelonidæ; but no fragment is sufficiently perfect to permit of the determination of even the genus, with certainty.

Among the other specimens is a single imperfect large vertebra of a Plesiosaurian. The centrum measures in length 90 mm., in height 115 mm., and in width 125 mm. It is probably the dorsal vertebra of a species of *Cimoliosaurus.*

The little light thrown by the remains on the age of the deposit seems to be in favour of the beds being Upper Cretaceous.

FOSSIL FISH REMAINS FROM NATAL.

PART I.

I.—NOTES ON CRETACEOUS FISH TEETH FROM THE MOUTH OF THE UMPENYATI RIVER, NATAL.

II.—NOTE ON SOME FOSSIL FISH SCALES FROM THE COAL MEASURES OF SOMKELE, ZULULAND.

By A. SMITH WOODWARD, LL.D, F.R.S., F.G.S., &c.,
Of the British Museum.

FOSSIL FISH REMAINS FROM NATAL.

PART I.

I.—NOTES ON CRETACEOUS FISH TEETH FROM THE MOUTH OF THE UMPENYATI RIVER, NATAL.

II.—NOTE ON SOME FOSSIL FISH SCALES FROM THE COAL MEASURES OF SOMKELE, ZULULAND.

BY

A. SMITH WOODWARD, LL.D., F.R.S., F.G.S., &c.,

Of the British Museum.

I.—CRETACEOUS FISH TEETH.

The teeth of Selachian fishes obtained by Mr. W. Anderson from the mouth of the Umpenyati River have a distinctly Cretaceous facies. Like all such fossils, however, they cannot be readily assigned to well-defined species; while most of them are so much waterworn and battered that their distinctive characters are a little obscured.

Cestracion sp.—Part of a small crushing tooth of *Cestracion* is exposed in the matrix with a large tooth of *Lamna basalis*. The crown is marked with a coarse and very prominent reticulation, and its end is rounded as in *C. canaliculatus* from the English chalk.*

Scapanorhynchus aff. rhaphiodon (Ag.).—Teeth of *Scapanorhynchus* with a striated inner face occur in the Cretaceous of all parts of the world, but it is still impossible to give them specific names. One incomplete basal half of a tooth of this genus from Natal shows the conspicuous inner striations, which are coarser, more prominent, and more regularly parallel than those of the common *S. rhaphiodon* of the English chalk. An exactly similar tooth has been found by Mr. Anderson in limestone at Umkwelane Hill, Lake Isitesa, Zululand. Part of a nearly similar but stouter tooth from Pondicherry has been wrongly identified with *Enchodus serratus* by Stoliczka.†

* For references to the various species see Catalogue of the Fossil Fishes in the British Museum, Pt. 1 (1889); also A. S. Woodward, Notes on the Sharks' Teeth from British Cretaceous Formations. Proc. Geol. Assoc., vol. xiii. (1894), pp. 190–200, Pls. v., vi.

† F. Stoliczka, Cretaceous Fauna of Southern India (Palæont. Indica), vol. iv., Pt. 4 (1873), p. 69, Pl. xii., Fig. 41.

Scapanorhynchus subulatus (Ag.).—A few small, smooth teeth, evidently much waterworn, agree closely in shape and size with those from the Cretaceous of Pondicherry named *Odontaspis constrictus* by Egerton.* An imperfect anterior tooth exhibits the base of a well developed lateral denticle; and a nearly complete side tooth (Pl. X., Fig. 1) has the single pair of lateral denticles large and broad, though pointed. There can be little doubt that these and the Indian teeth are referable to the widely-distributed Cretaceous species originally named *Lamna* (*Odontaspis*) *subulata* by Agassiz on the evidence of European specimens.

Scapanorhynchus sp. or *Odontaspis sp.*—One much waterworn front tooth agrees remarkably well in shape with that from Pondicherry named *Lamna sigmoides* by Egerton,† but is slightly larger, and a little inclined backwards. It is insufficient for exact determination.

Oxyrhina aff. mantelli (Ag.).—Three large teeth of *Oxyrhina* in many respects suggest the almost universally distributed Cretaceous species, *O. mantelli*,‡ but they are comparatively stout, and differ a little in shape from the teeth of this species. A front tooth from Natal (Pl. X., Fig. 2) tapers more suddenly at the apex, and is here more sigmoidally bent than the corresponding tooth of the typical *O. mantelli*. A side tooth (Pl. X., Fig. 3) apparently exhibits basal lateral wings less extended than usual, while its apex is slightly twisted. Though the specimens do not agree precisely with any known teeth, it is inadvisable to propose a specific name for them until a larger and more varied collection is available for study.

Lamna basalis (Egerton).—The most numerous teeth from Natal resemble those of the typically Cretaceous *Lamna appendiculata* in general aspect, but differ in being thinner and more compressed at the base. They therefore agree with the teeth from Pondicherry named *Otodus basalis* by Egerton.§ One front tooth (Pl. X., Fig. 4) shows the inward inclination of the lateral denticle noted by Egerton, but the other teeth from the side of the jaw (Pl. X., Fig. 5) do not exhibit this feature. A large lateral tooth (Pl. X., Fig. 6), measuring about 2 cm. in width, displays the extreme inward prominence of the middle of the base, which is much less than in the typical *Lamna appendiculata*.

Corax falcatus (Ag.).—An imperfect small tooth (Pl. X., Fig. 7), and waterworn fragments of teeth of *Corax* seem to correspond most closely with the teeth of the widely-distributed species *C. falcatus*. The crown in the best preserved tooth is much broader than deep, with the anterior border nearly as much arched as in *C. pristodontus*, and the posterior border slightly indented. In a fragment of a smaller tooth the posterior indent is sharper, almost separating a short and

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* P. M. G. Egerton, On the Remains of Fishes found by Mr. Kaye and Mr. Cunliffe in the Pondicherry Beds. Quart. Jour. Geol. Soc., vol. i. (1845), p. 171, with fig.

† *Loc. cit.*, p. 170, with fig.

‡ C. R. Eastman, Beiträge zur Kenntniss der Gattung Oxyrhina. Palæontogr. vol. xli. (1894), p. 154, Pls. xvi–xviii.

§ *Loc. cit.*, p. 168, with fig.

broad denticle from the crown. Another fragment demonstrates the solid nature of the tooth.

Enchodus sp.—One indeterminable fragment probably belongs to a large palatine tooth of the Cretaceous Teleostean, *Enchodus*.

II.—COAL-MEASURE FISH SCALES.

The scales associated with fossil plants in the grey shales of the Somkele coalfield are thin and cycloid, displaying the fine concentric lines of growth (Pl. X., Figs. 8, 9). They are never deeper than long, though sometimes longer than deep; and their posterior edge is rounded, while their anterior edge is sharply truncated and straight. Their exposed portion is a comparatively small sector, completely ornamented with numerous fine longitudinal ridges, which are smooth, more or less wavy, and branching or intercalated forwards, tending to converge towards the middle point of the scale behind. The ornamental ridges do not appear to end in serrations at the posterior border. The large covered area of each scale is marked by a few shallow furrows, which radiate from the centre to the truncated anterior border, and produce wavy distortions in the fine concentric growth lines.

So far as I am able to discover, these scales are unique, and cannot be assigned with certainty to any known type of fish. In most respects they are very suggestive of Cœlacanth scales, and they may even be compared with the cycloid scales of certain rare Palæoniscid fishes. They differ, however, from these and from all scales of so remote a date by the peculiar radiate furrowing of the covered portion. Before naming them it would be well to await the discovery of other parts of the fish to which they belong.

GEOLOGY

OF

THE EASTERN HALF

OF

ALFRED COUNTY.

GEOLOGY

OF

THE EASTERN HALF

OF

ALFRED COUNTY.

GEOLOGY OF THE EASTERN HALF OF ALFRED COUNTY.

This is the most southerly county in Natal, and borders, with the intervention of the Umtamvoona River, on Pondoland, Cape Colony. This Report deals chiefly with the eastern portion of the county from the sea coast inland to the west of the sandstone plateau which extends northwards through the middle of the county. This area is drained by the lower reaches of the Umzimkulu and Umzimkuluana Rivers, by the shorter streams which flow from the sandstone plateau to the sea, and by the northern tributaries of the Umtamvoona River. The coast-line is low, and never presents precipitous features. In its northern portion, where it consists chiefly of Ecca Glacial Conglomerate (Dwyka), the usual sand-dunes are generally absent and the rock exposures are sparsely covered with sand. In the southern portion of the coast, however, down towards the Umtamvoona River mouth and on the granite and Table Mountain Sandstone outcrops higher up, the sand-dunes are plentiful and of considerable height. On the high ground close to the mouth of the Umtamvoona River, on the northern side, a large area is occupied by a compact chocolate-coloured sand, similar to that which occurs so frequently on the North Coast of Natal in Victoria County and also among the loose white, wind-blown sands which form the sand-dunes on the coast of Zululand. Although the main feature of this country is the precipitous scarp of the Table Mountain Sandstone plateau, rising from the comparatively low undulating coastal area, it is much diversified by the extensive erosion of the rivers, which has produced on the rocks of the different formations great diversity of contour.

The physical features of this area are quite similar to those of the country immediately to the north. That is to say, there is a stretch of low undulating country occupying the coastal area, extending sometimes as far inland as eight or ten miles, backed, immediately to the west, by a plateau of Table Mountain Sandstones. The precipitous eastern edge of this plateau gradually approaches the coast towards the south and comes quite close to it, north of the mouth of the Umtamvoona River. The low coastal area consists of granite and Ecca Glacial Conglomerate (Dwyka), and in the valley of the Ivunga River, of an outlier of Table Mountain Sandstones, which

forms the highest portion of the coast area. It is an exceedingly well watered country, and the rivers—the Umzimkulu, Umzimkuluana, and the Umtamvoona — have cut enormous gorges through the Table Mountain Sandstones to a great depth, thus producing a most rugged and difficult country. In the valleys of each of these rivers the sandstones have been completely cut through, producing a precipitous sandstone scarp, while below they have penetrated the granites to a considerable depth, leaving steep slopes, which are usually covered with timber. Many portions of these gorges are quite impassable owing to the well-timbered slopes, the habitat of large troops of baboons, while the dangerous sandstone precipices of the upper part of the canyons can only be used as a passage in rare and favourable positions. In many places, however, the natives have formed tracks which wind over the sides of these canyons, but it is often with difficulty these are negotiated, particularly with horses, to which some of them are entirely impassable. The views obtained from some points of vantage on the heights above these canyons are wonderfully fine. One in particular, from the main road some two miles to the east of Mehlomnyama, where one can look nearly two thousand feet down into the bend of the river in the valley below; while a long vista of the river-canyon, at one of its finest parts, is exposed to view, with its steep timber-clad sides edged off by the yellow sandstone precipices, which frequently appear at intervals, in the distance, from the winding of the river valley, long after the canyon has closed to view. The whole view is backed on the sky-line by the Ingeli Mountains, which at the time I saw this view to the best advantage were white with snow, and presented a resplendent background with the sun-glint on the snow. Where the valleys are open to any extent and moderately level ground occurs in the neighbourhood of the river, and even frequently on the steep slopes, they are dotted with native kraals, with their usual accompaniments of mealie gardens and mabele patches. In many instances these latter seem as if they were hanging on nearly perpendicular slopes. As a rule the soils formed on the lower portions of the valleys are comparatively rich, and although there are very few alluvial flats of any extent, many of the lower ridges produce remarkably good crops. Exceedingly large areas of this county are given over to native locations, and, as usual, they comprise the richest agricultural lands, which are only to a very minor extent made use of by the natives for the cultivation of their crops, while their grazing lands are far in excess of their requirements. The largest reserve for natives is in the southern part of the county, between the sandstone plateau and the coast. It embraces a very large extent of the outcrop of the granite and gneiss in this district. Although a good deal of this granite country consists of rock-outcrops, by far the larger portion of it is covered with a good depth of soil, which both in the river valleys and on many of the ridges is of very good quality and produces crops of excellent commercial value.

There is so much bush and timber in the gorges and on the slopes

of the valley where of any width, that game may be said to be quite plentiful compared with most other parts of Natal proper. That large portion of the sandstone plateau, above the occurrence of the marble, and between the two gorges of the Umzimkulu and Umzimkuluana Rivers, is still called the Oribi Flats, from the presence in the old days of large herds of oribi, which even to the present day are still in considerable numbers on this portion of the plateau.

In this Report the southern portion of Alexandra County is taken in, between the Umzimkulu River and the Umzumbi River. This area is chiefly granitic and presents a smoothly undulating country; but in the immediate vicinity of the rivers, which have cut deeply into the granite, the valleys, although of no great width, are steep and somewhat difficult of access. The plateau portions, however, where most of the kraals are, are wonderfully fertile and well watered, as all the small streamlets and tributaries of the larger streams have their origin in springs. This area is practically all native location except for a narrow strip on the coast, and, like most of the other parts, is, particularly in the valleys of the tributary spruits, well timbered. Such alluvial flats as occur on these streams and the low flat areas between the bends of the streams are largely taken advantage of by the natives for mealie cultivation.

On the Table Mountain Sandstone plateau the loose sandy soil is specially adapted for the growth of wattles, and, like the other elevated sandstone areas in Natal, such as the Noodsberg, &c., a considerable extent of this plateau is occupied by plantations of wattle trees, which do remarkably well. During the colder period of the year much of this plateau country is used for winter grazing for cattle, which are brought down from the higher portions of Griqualand East. The eastern edge of the plateau is so close to the sea coast and is of such an elevation that the plateau is always throughout the year well supplied with moisture, both in the form of rain and the condensation of mists, which are of very frequent occurrence during the night. It is exceedingly well watered, as most of the smaller streams have their sources on the plateau in the innumerable springs, often of strong volume, which flow from the sandstones. Most of these smaller streams are permanent, and in cases where they do dry up for a time, there are always large pools of water at intervals along their courses. It is the presence of these streams, as they pass through the coastal area, which gives to it its agricultural possibilities. The soils on the coastal belt are different from the sandy soils of the plateau or those in the deep granitic valleys of the rivers, inland, because the formations from which they are derived are more diversified, consisting as they do of representatives of all the formations occurring in the district. The growth of aloes for their fibre is an industry which is wholly confined to this coastal part of the Colony. Lately, an extensive new plant has been erected on the fibre company's ground near the Ivunga River. The cultivation is always carried on on country which consists of Ecca Glacial Conglomerate (Dwyka).

The formations represented in this district are, from below upwards, as follows:—

Granites and Gneisses.
Schists and Marble.
Table Mountain Sandstones.
Ecca Glacial Conglomerate (Dwyka).
Ecca Series (Glacial Shales).
Cretaceous (Upper).
Recent and Pleistocene Sand-dunes.

The granites and gneisses are by far the most extensively developed of any of the rocks which occur over this area, outcropping on the coast, to the north of the Umhlangankulu River and between the Inkongweni and Inhlanhlinhlu River, to the south of Port Shepstone. They occupy, over a considerable breadth, practically the whole of the sub-coastal area east of the Table Mountain Sandstone plateau, from the Umzumbi River to the northern watershed of the Umtamvoona River. In the southern portion of Alexandra County their outcrop covers almost the entire country north of the Umzimkulu River and as far west as the neighbourhood of St. Faith's. In the western portion of Alexandra County this granitic area passes northward to the east of Inhlongozi Hill and north-eastwards towards Umzinto. They occur in the bed of the Umtamvoona River some distance above the mouth. In the gorge of the Umzimkuluana they are present in the bed of the river nearly as far up as the surveyed block known as "Baboon Spruit," while on the Umzimkulu River they are exposed in the lower portion of the gorges as far westward as the Table Mountain Sandstone outcrop in Location No. 6, when the whole country on both sides of the river is occupied by the granites. Above Location No. 6*a* they still persist in the lower part of the river valley, although on the north side of the river the Table Mountain Sandstones overlie them, and on the south side, as far as the Ibisi River, the higher parts of the valley are covered with outcrops of Ecca Glacial Conglomerate (Dwyka). In these different areas the distribution of the granites and metamorphic rocks is as follows:—The granite, as true granite, is of the most variable composition, colour, texture, and quality, particularly on the coast and in Locations Nos. 4 and 5, to the east of the Table Mountain Sandstone plateau, where it is most largely developed. To the north of the Umzimkulu River, in the southern part of Alexandra County, it is chiefly of a gneissic character, with occasionally a few schistose rocks in association with the isolated patches of marble which occur on the north of the Umzimkulu valley. High up this valley the granites, as such, are quite distinct in the bed of the river, but some distance up the sides of the valley undoubted hornblendic and other schists occur, among which the marble is distinctly interlaminated. Good sections of the granite are of frequent occurrence inland, but the best are those exposed along the shore at intervals, to the south of the Inkongweni River. It is a highly porphyritic dark-coloured rock and is chiefly felspathic, the felspar

crystals being very large. This is its general feature on this outcrop, but towards the northern end of the outcrop it becomes less porphyritic and finer in texture. It is much cut by light-coloured pink veins of all sizes, consisting chiefly of pink felspar with quartz, which often cut each other at all angles. Intrusive dykes of fine-grained diabase are also common locally, but so far as I have noted mineral veins do not occur either frequently or of any great extent.

The gneisses do not outcrop to any extent in association with the true granites to the south of the Umzimkulu River. They occupy almost the entire area north of the Umzimkulu, between it and the Umzumbi River, but the transition between the two rocks is not well marked in any position in which I have seen it. The granite is certainly not intrusive among the gneisses, which are also present along the bed of the Umzimkulu River for a long distance, but to the westward, on the south of the river, they are probably covered by the Table Mountain Sandstones and younger rocks. In the area to the east between the plateau and the sea the true granite largely predominates. It would seem to me that this large extent of gneiss to the north of the Umzimkulu River forms a sheared portion of the granite mass. Except for the evidences of shearing, it closely resembles the various forms of the true granite which occur in the district to the south. It is only locally that the schists and marble are associated with the gneisses, and these form very small outcrops. Intrusive diabases are rare either in the granites or gneisses, and as a rule both the latter decompose in a fairly uniform manner, as it is rare to find large undecomposed rock surfaces or monoliths of either rock. One fairly extensive hog-backed outcrop occurs near the road about half-way between Port Shepstone and Mehlomnyama.

The first description of the geology of this district was given by Griesbach in the *Quart. Jour. Geol. Soc. London*, in 1871, where he describes his journey along the south coast and his visit to the marble beds of the Umzimkulu River. Since then a paper was read by Draper on the marble beds of Natal, but there are no other references to these deposits and the geology of the neighbourhood.

The schists with their associated crystalline limestones are not of frequent occurrence in this district, and do not cover large areas. In some cases the isolated outcrops of marble (as it is locally called) are not, to all appearance, associated with schists, but seem to be outliers resting immediately on the granitic rocks. The largest area occupied by these metamorphic rocks is the marble outcrop forming the Indwendwe Hill, formed by the junction of the Umzimkulu and the Umzimkuluana Rivers, about seven miles above Port Shepstone. This outcrop is the most important because it possesses facilities for transport in the presence of the river, which is tidal and deep enough to allow of boats approaching the base of the Indwendwe Hill for the conveyance of the lime from the quarries to the railway at Port Shepstone. The marble occupies almost the entire ridge between the two rivers as far west as the two surveyed portions, "The Forest" and "La Joncquet." In the Umzimkuluana valley it is associated with

chloritic and talcose schists, all resting on the granitic rocks. Besides outcropping on both sides of the ridge between the two rivers, the outcrop passes northward from the bed of the Umzimkulu River and occupies the major portion of the surveyed block called "Westlands" and the southern part of the surveyed block "Watershed." Further to the north, near the store close to the Mehlomnyama road, on the flat to the west of the Trappists' farm, another small outcrop occurs, and still further north, on the hills forming the watershed between the Upper Umtentweni and Umzimkulu Rivers, marble outcrops over a small area. In the bush reserve close to Mehlomnyama another small patch of marble is present. In all these latter positions there are no evidences of the presence of schists. To the south of the Umzimkuluana River a small outcrop occurs on the northern portion of the surveyed block called "Glendale," but this outcrop can be traced over the edge of the plateau into the valley of the Umzimkuluana River, where it seems to be more or less continuous with the main outcrop above the junction of the two rivers. There are probably other outcrops further up the Umzimkulu River, in the lower portions of the valley, but for all practical purposes they need not be regarded, because of their inaccessibility. The furthest west outcrop was discovered by the Hon. Mr. Hutchinson, who kindly took me to see the locality. It is situated in the Umzimkulu valley, some miles below the junction of that river with the Ibisi River. From Mr. Hutchinson's house, on the main road between Harding and Port Shepstone, to within half a mile of the Umzimkulu River the surface rock is Ecca Glacial Conglomerate (Dwyka). In descending the last slope into the river bed the marble outcrop occurs on the ridge, immediately after passing off the Glacial Conglomerate, which here rests directly on these older metamorphic rocks, without the intervention of the Table Mountain Sandstones. The outcrop begins about half-way down the slope of the valley of the Umzimkulu River, and the marble can be traced almost vertically down to the level of the river, where, however, the granitic rock shows beneath it. Here the granitic rock is much intersected by the intrusion of basaltic rocks, but these are not observable in the marble or the schists. On the ridge and at the river level, the marble is in association with hornblende schists with quartz and felspar rocks. The strike of the schists and their junction with the marble can be distinctly seen, and its direction is W. 17 N. The marble here is very coarsely crystalline calcite, as it is on most other outcrops. This is a most important section, because it is one of the few occurrences where the marble is undoubtedly interlaminated with the schists and the junction between them and the granite can be seen.

There is little doubt in my mind that the granite has intruded the series of schists containing the marble, and that the metamorphism of the latter has been caused thereby. The numerous small outcrops of these rocks are the remnants of a metamorphic series which probably has been of great extent, but which has been almost completely denuded away before the deposition of the Table Mountain Sandstones. Between these series of rocks there is a great unconformity,

and doubtless the denudation of the metamorphic series has chiefly furnished the material which now forms the Table Mountain Sandstones, although pebbles and pieces of metamorphic schists, &c., are not common in the latter formation. This can easily be explained, however, by the fact that what pebbles do occur in the Table Mountain Sandstones always consist of hard and not easily degraded rocks, such as quartz, quartzites, &c., and must have undergone, as shown by their well-rounded forms, a great deal of attrition, which the schists, being so soft and friable, would not stand.

High up the Umzimkulu River, where the Hon. Mr. Hutchinson showed me the marble outcrop, the strike of the junction of the marble with the schists was distinctly seen to be W. 17 N., and the different strata were standing nearly vertically. On the Indwendwe Hill, at the junction of the Umzimkulu and Umzimkuluana Rivers, as pointed out by Draper, the granite is exposed on the top of the hill and the marble seems to dip into both river valleys at a steep angle. Here the strike would also appear to be almost nearly east and west, so that the direction of strike would practically coincide in both localities. There is no doubt, at the furthest west outcrop up the Umzimkulu River, of the intrusive character of the granite, and I think that it is equally well established at the Indwendwe Hill outcrop, where I see no reason for the intervention of faulting to account for the various levels at which the marble occurs to the north and south of the two rivers. It seems quite plain that the marble is present on the Indwendwe Hill as an anticline, the top of which has been denuded away, exposing the granitic rock at the top of the hill. In each river bed the marble forms a syncline, while to the south, on "Glendale," the outcrop terminates on another anticline, and on the north of the Umzimkulu River a third anticline occurs on "Watershed," and the small outcrop on the hills forming the watershed between the Upper Umtentweni and the Umzimkulu represents a portion of a fourth anticline. In fact, there has been a crumpling of the strata which has produced a series of anticlines and synclines, the axes of which are nearly east and west, and from the direction of the strike higher up the river, the crumpling must have been uniform over a large area, although now we have only a few isolated outcrops of these rocks left. This explanation of its occurrence does away with the necessity for the introduction of faults to account for the present position of the marble. There are no surface evidences of faulting in the immediate vicinity of the schists and marble outcrops. As stated further on in this Report, the fact of the sandstones some miles up the river valley having a decided dip to the north-east has not been due to faulting, but to an entirely different cause, which could have had no effect whatever on the present position of the schists and marble. In fact, all through, the district is wonderfully free from any evidences whatever of extensive faulting. The uniform horizontality of the sandstones goes far to prove this.

From its position among the schists, the marble has undoubtedly originated as a sedimentary deposit. Since its metamorphism it has been converted into a very coarsely crystalline limestone, consisting

present from the mouth of the Umtamvoona River, stretching northwards through the county, gradually receding from the coast. At its coastward edge it is marked by a precipitous outcrop which can be seen from most parts of the coastal area. A large outlier of this formation occupies the valleys of the Ivunga and Inkongweni Rivers on the coast, while a smaller outlier is present close to the coast between the Itongazi and Umkandanhlovo Rivers. Other small outliers occur in the valleys of the Izotsha and Imboboye Rivers some distance from the coast. The Table Mountain Sandstone plateau is very extensive, for although at the mouth of the Umtamvoona River it narrows considerably, to the north on the Umzimkuluana River the sandstones outcrop for a distance of 12 miles before they disappear under the Ecca Glacial Conglomerate (Dwyka) in the west. For about a mile above the mouth of the Untamvoona River the sandstones form the bed of the river, but about this point the granite appears and forms the lower portion of the valley for a considerable distance up the river. This can be well seen where the first large creek, on the north side, enters the river from its left bank. The depth of the canyon here is about 1,000 feet, and less than the upper half of it consists of approximately horizontal beds of Table Mountain Sandstones, while the lower part of the canyon has been excavated in the granite, which also outcrops for some distance up the bed of the above-mentioned tributary. At the mouth of the Ivunga River there is a very fine picturesque section of these rocks, close to the sea-shore, where the river before reaching the coast flows over a cliff of sandstone of some height. This outlier of the sandstones is of considerable extent and persists to the west a good way into Location No. 5. About half a mile to the west of the crossing of the main road over the Ivunga River, the sandstones have a steep dip to the east, but this is only local. At the mouth of the same river there is a set dip to the south, very slight, but quite apparent. As a rule, however, they are practically horizontal over most of their outcrops. They are generally thin bedded and show false bedding, but in some localities individual beds attain a thickness of 40 feet or more, but these thick beds are never of great extent. There are no quartzites or shales anywhere in this area associated with the Table Mountain Sandstones. Wherever the latter outcrop, whether on the coast or on the plateau, they are characteristically pebbly grits. The sand-grains are coarse, and the pebbles are usually less than the size of a pigeon's egg and very uniform in size. They are always beautifully rounded, circular or oval, and highly polished. They chiefly consist of pure white, opaque and translucent, or a dull blue-coloured quartz and occasionally ironstone. The prevailing rocks are, however, quartz and quartzite. They occur usually in layers, sometimes extensive, but isolated, and very frequently in small horizontal patches. Their occurrence is exceedingly general wherever the sandstones outcrop. On horizontal surfaces of the sandstone, exposed by weathering, the pebbles, loosened by denudation from the rock, form quite a feature as they lie strewn over the exposed surface,

practically *in situ*, in the position which they had originally occupied in the sandstones.

The frequent occurrence of pebbles of quartzite of many different kinds, not only in the Table Mountain Sandstones, but also in the Ecca Glacial Conglomerate (Dwyka) of the east coast of South Africa, is curious when we consider that, so far as the older rocks are exposed over the area of what is now Natal and Zululand, series of rocks containing quartzites are practically unknown; in fact, they do not occur nearer than the Transvaal. Of course, it is possible that they may be present in Northern and Western Natal under the Karroo Series. Pebbles and even boulders (in the case of the Ecca Glacial Conglomerate) of quartzite are so abundant and so uniformly distributed, both in the Table Mountain Sandstones and the Ecca Glacial Conglomerate (Dwyka), wherever these formations occur in Natal or Zululand, that it seems more than probable that they were not all transported from long distances, as from the Transvaal, but that they had a more or less local origin. In this district the occurrence of the Swaziland Series is only represented by a few outliers, of small area and of no great thickness, but it is evident that the formation existed before the deposition of the Table Mountain Sandstones over a large area of what is now known as Natal and Zululand. In other parts of South Africa where this formation is well developed, quartzites are a common feature of it, and it is quite probable that its representatives which occurred over the East Coast area also contained quartzites, as well as the rocks we now find in the relics of that formation, crystalline limestones, and various kinds of schists. It is quite probable that a large proportion of the quartzite pebbles of the Table Mountain Sandstones and the Ecca Glacial Conglomerate (Dwyka) were derived from local exposures of the Swaziland formation, which has long been entirely denuded from the outcrops of the older granite and gneisses, now exposed over considerable areas both in Natal and Zululand.

Faulting, to any extent, is very rarely met with in the Table Mountain Sandstones of this district. A few instances occur where the local dip of the beds forming outliers, might lead one to conclude otherwise. Where these rocks show an exaggerated dip, in most cases it is due to the local intrusion of Diabase. In one instance, where a small outlier of Table Mountain Sandstones is isolated from the main outcrop, on the northern side of the Umzimkulu River, some miles above the marble occurrence at the Indwendwe Hill, the dip seems to be due to faulting. If, however, a minute examination is made of this part of the valley, it will be found that at one time, geologically recently, the Umzimkulu River, as we call it now, instead of flowing round the south-western side of this outlier, passed round its north-eastern side. The probability is that the north-easterly dip of the sandstone beds of the outlier has been produced, not by faulting, but by a local phenomenon which is not uncommon, viz., a landslip into the bed of the river. This has carried away the mass of sandstones and placed it at a much lower level than the main outcrop forming the Oribi Flats, and given it a decided dip to the north-east.

Subsequent to this, the river has altered its course to the western side of the sandstone outlier. A similar occurrence—and I think a more recent one—has taken place in the Glendale valley, in Victoria County, where the geology is similar to that of the Umzimkulu River valley, Table Mountain Sandstones above and granite below. Here, a large portion of the sandstones, with a decided dip into the valley, lies half-way down the side of the valley, and has evidently been put into position by a landslip. In fact, when looking at it from above, the irregularities left in the cliff can be seen to correspond with those on the upper edge of the sandstone outlier.

The Ecca Glacial Conglomerate (Dwyka) is chiefly developed along the coast, the main mass occurring in the basins of the Imboboye and Izotsha Rivers, immediately to the south of Port Shepstone and the mouth of the Umzimkulu River. It also covers a large area of country to the west of the Table Mountain Sandstone plateau, and occupies not only the elevated country forming the watershed between the Umtamvoona and the Umzimkuluana Rivers, but also a portion of the upper valley of the latter river. It covers the country to the north-west, forming the watershed between the Umzimkuluana and the Umzimkulu Rivers, and practically overspreads the entire country from the Umtamvoona River, south of Ezingolweni, to the Ibisi River, some distance above its junction with the Umzimkulu River. Another considerable area occurs to the south-west of the Police Camp at Mehlomnyama, occupying the plateau on the opposite side of the deep valley in front of the camp, and passing down to the sandstone cliffs overlooking the valley of the Umzimkulu River. This outcrop partially rests on Table Mountain Sandstones at its south-eastern end and on granitic gneisses further north. The glacial conglomerate exposed to the south of Port Shepstone, on the coast, rests upon Table Mountain Sandstones; while the large area to the west of the sandstone plateau partly rests on Table Mountain Sandstones, in its eastern portion, and on the granitic gneisses in its western development. So far as I was able to detect, glaciated pavements on the rocks on which it rests are of rare occurrence, and when present are exceedingly indistinct. The granite rocks do not lend themselves to the retention of glacial striæ, because they readily undergo decomposition where there is an unconformity, such as exists between them and the Ecca Glacial Conglomerate (Dwyka). The Table Mountain Sandstones being very coarse-grained, and often pebbly, also readily undergo decomposition, and therefore a very short exposure of their surfaces removes entirely or defaces such groovings as may have been originally present. Further to the north, on the coast, a mile or two to the south of Park Rynie, the striæ on the surfaces of the Table Mountain Sandstone distinctly point to a north and south direction as the source of the ice, and it is more than probable that the same obtains in the more southern district of Alfred County. In all the localities of the exposures of Ecca Glacial Conglomerate (Dwyka) the rock is typical and similar to most other outcrops in the Colony. The pebbles and boulders are chiefly granites, igneous rocks and quartzites, many of which may

have had a local origin. So far as I saw, no specimens of marble occur. This is not surprising, owing to the easily abraded character of the rock.

Ecca Shales overlying the glacial conglomerate are sparingly developed in this district, and are almost entirely confined to the vicinity of the mouth of the Umzimkulu River in the neighbourhood of Port Shepstone. The larger area occupied by the Ecca Shales is on the north and south bank of the lower portion of the Umzimkulu River from its mouth, for a distance of about three miles up the river. On the north side of the river they occupy the lower part of the valley of the Umtentweni River, and on the south of the river a portion of the basin of the Umbango River. A small exposure is present on the watershed between the Imboboye and Izotsha Rivers, but this is of very limited extent. With these two exceptions no other outcrops of Ecca Shales occur in this district. They are again, however, exposed to the west of Alfred County, and there cover a very large area both to the north and south, while further to the west they are overlaid by the Beaufort Series, and on the Drakensberg by the overlying series of the Upper Karroo.

The Port Shepstone outcrop consists chiefly of dark-coloured, finely-laminated shales, with the usual diabasic intrusions. They undoubtedly belong to the Ecca Glacial Shales, and have not yielded any specimens of fossil plants. A few specimens of a calcareous mud-stone were dredged from the mud at the bottom of the river, close to its mouth, which contained undoubted traces of fossil plants, but they were too indistinct for identification, although one or two of them looked not unlike the fluted stems of *Phyllotheca*. This calcareous rock, wherever it originally came from, has no connection with the marble or other associated beds of metamorphic origin; and so far as I know, there is no rock in any way resembling it among the shales which constitute the Ecca Shales of this district.

The Cretaceous rocks are limited to one outcrop exposed on the shore between tide-marks, between the mouths of the Umhlengeni and Umpenyati Rivers. A short description of these beds is given at p. 50 of the present Report, and therefore need not be repeated here. At the mouth of the Boboi River, on its northern side, a very small outlier occurs of apparently horizontal sedimentary strata resting on the granite. Although I obtained no fossils from these beds I should be inclined to suppose that they are the remnants of an outlier of the Cretaceous rocks which occur up the coast to the north, as it is unlikely they could be either Karroo Shales, Tertiary, or more recent deposits. It is, however, a very insignificant outcrop. The next outcrop of these Cretaceous rocks occurs some miles to the south of the Umtamvoona River mouth in Pondoland. All the Cretaceous rocks of this coast are referable to some portion of the Upper Cretaceous of Europe.

Although limestones are associated with these rocks they are too impure and earthy to be of use for the manufacture of lime, notwithstanding the fact that they usually contain very large numbers of fossil Mollusca, &c.

The Pleistocene and Recent deposits are naturally chiefly confined to the coastal area. There are few deposits of alluvial of any extent in the river valleys, principally owing to their narrowness and exceedingly precipitous character. The sand-dunes and other sand deposits in the neighbourhood of the coast are much more sparingly developed than they are either on the North Coast of Natal or on the littoral of Zululand, and the sand-hills do not attain to anything like the height of those of the Zululand coast. Where the sands are of any superficial extent they are of no great depth. Evidences of early man, in the form of kitchen middens, &c., are not of common occurrence.

Unfortunately, the completion of this survey was interrupted when at its most interesting and important stage, the investigations concerning the crystalline limestones, which will probably in the future form the chief mineral industry in the district. This is the reason why this Report is so meagre. Such unfortunate results are, however, certain to accrue when the control of a scientific department is vested in persons who are hopelessly ignorant, either of the science and its methods or of what the legitimate outcome of the work should be.

ON THE DISCOVERY

IN

ZULULAND

OF

MARINE FOSSILIFEROUS ROCKS

OF

TERTIARY AGE, CONTAINING

MAMMALIAN REMAINS.

ON THE DISCOVERY IN ZULULAND OF MARINE FOSSILIFEROUS ROCKS OF TERTIARY AGE, CONTAINING MAMMALIAN REMAINS.

In the southern portion of the continent of Africa rocks of Tertiary age, of marine origin, are of rare occurrence. In the interior of this part of Africa they are not represented at all, and the present occurrences in Zululand, like many of those already known in Africa, north of the Equator, are present, as fringing outcrops on the coast, in isolated localities, where they mostly overlie rocks of already known Upper Cretaceous age.

In the coastal regions of Equatorial and Northern Africa extensive areas are known to be occupied by rock of Tertiary age. In Morocco,[18] Algeria,[5] Tunis,[17] Egypt,[14] Abyssinia,[2] the Eastern Sahara,[4] Soudan,[7] and Nigeria,[11] extensive deposits of marine Tertiaries occur. To the south of the Equator Tertiary deposits are present on the coast of Loango[9] and at the estuary of the Congo[8] River. Their occurrence has not been authenticated further south on the west coast; while nowhere on the coast of Cape Colony have representatives of marine Tertiaries been recognised.

On the East Coast of Africa they have been recorded from many localities—from Somaliland[16] to south of Zanzibar,[3] and at Sofala,[12] in Portuguese East Africa,[6] while on the west coast of the island of Madagascar[13] they are largely developed, resting on fossiliferous Cretaceous rocks.

The sandstones, which cover superficially so large an area in Central South Africa, have been referred to the Tertiary period, but are supposed to be of fresh-water origin and have been named "Forest Sandstones" by Mennell[10].

At Uitenhage,[15] near Port Elizabeth, on the south-east coast of Cape Colony, rocks of Lower Cretaceous age occur, but there are no Upper Cretaceous or Tertiary rocks associated with them. Some miles south of the Umtamvoona River fossiliferous Upper Cretaceous rocks are present on the coast of Pondoland,[1] but no Tertiary rocks. On the Natal coast a similar occurrence takes place at the mouth of the Umpenyati River, where the Cretaceous Beds can be correlated palæontologically with those on the Pondoland coast, but here again they are the youngest rocks present. At the Bluff, Durban, where undoubted Upper Cretaceous rocks have lately been

proved to exist in a bore, at a depth of over 300 feet from sea-level, the superficial 300 feet of calcareous sandstones, which also form the rocks of the Bluff above high-water mark, will probably prove to be of Tertiary age. With this, at present, doubtful exception, we have, therefore, no evidences of the presence of marine Tertiary strata in South Africa until we get to that part of the Zululand coast to which I refer in this paper. From this point northwards along the coast they probably occur in Portuguese territory, as they do in Madagascar overlying the Cretaceous rocks which we know to be present there. Further to the north, Bornhardt [3] states that: "Between Cape" "Delgado and Kilwa Kisiwani extends a band of Tertiaries and" "alluvium. On 10° S. are Cretaceous (? Early Eocene) Beds," "south of this the Tertiaries fine off towards the west and terminate" "in 36° 35′ (about). A similar block of Tertiaries extends inland" "from the coast between Kilwa, Kisiwani, and Bagamoyo, reaching" "as far west as 37° 25′ (about). There is a band of Jurassic age" "near the coast, cropping out from among the Tertiaries somewhat" "north of 9°."

From these references it will be seen that marine Tertiary strata are of exceptional occurrence in South Africa, and that in their distribution they are confined to the east coast of this portion of the continent and do not occur, so far as is known, further south than Natal. It is quite probable, however, that strata referable to this period may be found in isolated positions in the interior, in the form of beds of fresh-water origin. Of the Tertiary strata, which are present on the east coast to the north of Natal and Zululand, there is, as yet, little or nothing known, except their occurrence, although a considerable amount of work has been done on the palæontology of the Tertiaries of the neighbouring coast of Madagascar. As they are usually very fossiliferous, there is no room for doubt that eventually, when they have been properly examined, they will prove a most interesting and important series palæontologically.

During the field-season of 1903, while working on the littoral of Zululand on some known Cretaceous rocks, a fairly thick series of beds was met with overlying the Upper Cretaceous Series, and outcropping in many places on the coast. The lower portion of these beds contain marine fossils with the remains of land Mammalia, while the upper portion consists chiefly of highly-coloured, false-bedded sands, with occasional carbonaceous beds, unfossiliferous and immediately associated with the Pleistocene and Recent sands of the littoral (section, Plate VII.). The actual junction between this series and the underlying Cretaceous rocks has not yet been observed, but it is likely that they are a conformable series. The lower marine beds do not outcrop nearly so frequently above tide-marks as the upper unfossiliferous sands do, but as a rule only a few of the fossiliferous marine beds are exposed between tide-marks. The upper false-bedded sands outcrop very commonly in sections of the sandhills on the immediate shore-line, and may yet prove to be of later date than Tertiary. In many respects they resemble the curious hard,

chocolate sands which occur so frequently under the Recent sands in Victoria and Alfred counties, on the Natal coast. Although often of great thickness, these sands rarely contain a single pebble, rounded or otherwise; but just to the north of the Umtamvoona River mouth there is a large, flat, wind-swept exposure of hard chocolate sand, over the exposed surface of which are scattered innumerable pebbles and boulders, mostly more or less rounded. This is the only instance along both the Natal and the Zululand coast of the occurrence of pebbles and boulders in association with these chocolate sands, which in every case occur between the bed-rock of the locality and the more recent wind-blown sands. So far as I have had the opportunity of examining these variously coloured sands, no fossils or traces of man, such as "kitchen middens," &c., which are so common among the Recent sands of the sand-dunes, have been observed, and yet in the sands immediately overlying them they are of very frequent occurrence. The colouring matter is in every case ferruginous. It is interstitial, coating the individual quartz grains, and it is rare to find quartz grains coloured internally, although such do occur. In the latter case the colouring of these grains has taken place prior to their degradation from their parent rock, while the interstitial colouring matter which gives a characteristic to these deposits has been deposited with the quartz sand during the deposition and formation of the deposits. Even in the carbonaceous beds which are associated with the highly-coloured sands large quantities of ferruginous material are present. This, however, is not to be wondered at when these beds are found to consist almost entirely of vegetable matter with large masses of timber, and probably having an origin under marshy, boggy conditions. It is not at all unlikely that these chocolate-coloured sands of the Natal coast in Victoria and Alfred counties will prove to be contemporaneous with these sandy beds overlying the fossiliferous marine Tertiary rocks of the coast of Zululand.

The division between these sand-beds and the fossiliferous marine strata below is usually a more or less sandy lignitic bed (carbonaceous), containing large pieces of timber which are comparatively well preserved. The vegetable matter forming the matrix between the pieces of timber is quite amorphous, and shows no traces of leaf structure which could be even generically identified. This lignitic bed is, however, not always present, and then the sandy beds rest immediately on the fossiliferous marine shales. When this occurs the lower layers of the sandy beds contain enormous numbers of fossil spores and spore cases, the few inches of which no doubt represent the few feet of lignitic rock which is on the same horizon elsewhere, the two having been formed contemporaneously but under different local conditions. This thin fossil spore bed is very persistent, and can be easily traced for long distances. The lignite where exposed is quite useless for fuel, and is not likely to improve in quality, in from the outcrop. These lignite beds occur at intervals outcropping on the coast from Port Durnford, northward, and they are probably in all cases a

contemporaneous series belonging to the Tertiary period. So far as I have been able to investigate, there are neither fossils nor pebbles in any of the sandy beds overlying the lower lignitic bed, except the unidentifiable remains of wood, &c., in the upper carbonaceous bed.

A complete section of these beds, from the Recent blown sands to the lowest shales which produced the mammalian remains at exceedingly low tide, is given on Plate VII. From above downwards the section is as follows: Pleistocene and Recent sands (unconformity); considerable thickness of variously coloured, false-bedded sands; lignitic bed, or, in places, spore bed; hard, ferruginous sand; blue shales, soft, containing fish remains and few bones; thin, ferruginous layer with Foraminifera; thin layer, with Ostrea and other marine forms; bluish-green shales (few fossils); blue shales with fossil wood, mammalian bones, &c.; blue shale, thin, with comminuted shells; and below the lowest tide, red sandstones with no fossils. These last-mentioned beds are only exposed at neap tides, in conjunction with a heavy, south-easterly gale, which has the effect of sweeping off the superincumbent sand which, at usual times, covers the lower series of fossiliferous beds from view. Unfortunately, after a few days, as the gale subsides, the resultant swell gradually, at every tide, brings the sand back and re-deposits it on the outcrops below high-water mark. Most of the mammalian remains were obtained from this outcrop, which is usually covered deep in sand. The remains were extremely rich in specimens, which chiefly consisted of isolated bones and teeth, frequently fragmentary, while most of them had undergone considerable abrasion before being interred in the deposit. Occasionally, a part of a skeleton is preserved, with the various bones in position. In one case a specimen was obtained of an entire pelvic girdle. It was exposed on the upper surface of a large isolated block of shale. When first seen it was a perfect specimen, so beautifully cleaned by the erosion of the waves and the attrition of the sand carried in the waves, that one could have imagined the fossil had been exposed by the most careful human manipulation. The pelvis was complete, and below it lay exposed a portion, evidently of the lumbar region of a vertebral column, attached to which were a number of ribs, which, however, were not complete. It was with great difficulty that this specimen was secured; the block was so close to low-water mark, and was of so unwieldy a character, that much labour had to be expended in getting it reduced to a size sufficient to allow of its being rolled above high-water mark, where again it had to be broken into three for transportation to camp, as the intervening country was impassable, even for a sledge. Other large masses of bones were observed, but the laboriousness of the work of excavation and the quickly-subsiding south-easterly swell compelled me to leave these under their protective covering of sand, and owing to the short and infrequent periods at which the tide suits for excavation, it has been impossible as yet for me to secure these specimens.

Among the mammalian remains the following genera occur: Elephant, Rhinoceros, Hippopotamus, a scapula of a Cirenian identified

by Dr. A. Smith Woodward. The remains are described further on in this Report by Professor Scott.

Of the other fossil remains which occur in the same shales with the Mammalia, the chief are fish and Crustacea. No remains of Mollusca occur except in the lower foot of shale, where it is a mass of comminuted shells resting on the red sandstone. Immediately above the shale, Mollusca, chiefly *Ostrea*, &c., are the principal forms. After a cursory examination of these fossils my friend Mr. R. Etheridge, of Sydney Museum, says in a letter to me that "they are Tertiary and" "possibly Eocene." Immediately above this is a thin layer just below the lignitic bed, which produced enormous numbers of Foraminifera. All along this coast large numbers of fragments of a calcareous sandstone lie strewn about the beach. These have evidently been thrown up from some lower sea outcrop, and many of them contain large quantities of Foraminifera. Specimens of the thin foraminiferal layer and microscopic sections of many sandstone boulders were sent to Mr. G. J. Hinde, of the British Museum, who identified them as more likely to be of Tertiary than Cretaceous age. His report is as follows:—"Sections Nos. 460, 461, 462.—The rocks are mainly" "of minute angular quartz grains, with some glauconite grains" "and comminuted fragments of organisms, including Foraminifera" "of the kinds mentioned below. The sand-grains and organisms are" "cemented by finely granular calcite.

"Sections Nos. $463^{i.\,ii.}$, $464^{i.-iii.}$, $465^{i.-vi.}$, $466^{i.\,ii.}$, $467^{i.-v.}$.—The" "rocks in these various sections are of a very similar character, and" "they differ from the preceding chiefly in the larger size of the" "quartz grains and their rounded forms and in the larger proportion" "of organic remains. For the most part these are, though frag-" "mentary, in good preservation, and their minute microscopic" "structures are well shown. They comprise: *Lithothamnion*.—" "Small pieces of a branching species of this calc-alga are present" "in nearly all the sections. The cellular structure is well preserved." "*Foraminifera*.—These organisms are very abundant and present" "throughout. Their minute characters are frequently as well seen" "as in recent specimens. They belong to the following genera:" "*Miliolina*, *Biloculina*, *Triloculina*, *Quinqueloculina*, *Spiroloculina*." "These forms are very common.

"*Textularia* of several species, all arenaceous, very common." "*Globigerina*, very rare; *Truncatulina*, common; *Pulvinulina*," "*Rotalia*, *Amphistegina*, not common; *Polystomella*.

"Fragments of plates of Echinoderms, showing the characteristic" "structure; possibly some belong to Holothurians. Generally" "distributed in all the sections.

"Fragmentary branching Cyclostomate polyzoa, common." "Pieces of Molluscan and Entomostracan shells.

"These sections, as regards the organisms, are generally similar" "to those I examined in 1902 (Second Report, p. 49), and they are" "probably of the same geological age, which, judging from the" "character and condition of the organisms, is probably Tertiary."

This discovery of mammalian remains in Tertiary Beds of marine origin is of considerable importance to South African Geology, when we consider the recent discoveries of those remarkable extinct animals which have been obtained by the officers of the Egyptian Geological Survey in the Tertiary Beds of the Fayûm desert. In the fossils of the Tertiary period we are dealing with the connecting links of the zoological life of the present time with that of the far back past. It is, therefore, from a comparative zoological point of view, one of the most interesting and important series of fossiliferous rocks which we know. I have great hopes that these mammalian-producing beds may yet be found in more accessible parts of the country, and under physical conditions more favourable to the work of exploring them; for there is a very large area of country, certainly much covered with Pleistocene and Recent sands, little populated, and practically impassable during the wet summer season, in which it is quite probable that outcrops of these beds may occur in isolated localities. I have noted beds whose marine fossils, although in a bad state of preservation, my friend Mr. Etheridge has suggested to be probably of Tertiary age, at some twenty miles inland from the coast, so that on this part of the littoral there is quite a likely chance of the beds containing mammalian remains being discovered in some of the deeper-cut sluits and stream-worn dongas. This instance is probably not the only one of the occurrence of these beds inland, at some distance from the coast, and other discoveries probably only require the necessary opportunity for a systematic search. Nothing can be done in the country I speak of, without an organised transport, and the country can only be visited, with any hope of doing good work, during the dry season of winter, as most of the littoral area is impossible for transport during the rainy summer season.

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THE GEOLOGY OF THE HLABISA DISTRICT, INCLUDING THE SOMKELE COAL-FIELD.

THE GEOLOGY OF THE HLABISA DISTRICT, INCLUDING THE SOMKELE COAL-FIELD.

This area comprises that portion of Zululand, in the neighbourhood of the Magistracy of Hlabisa, from the Umqueme Range, in the north, to the basaltic country to the south-east of the Somkele coal-field; and from the Black Umfolosi River, on the west, to the Makowe Hills, on the east. The main rivers draining this large piece of country are, the Umsindusi, a tributary of the Mkusi River, in the north; the Hluhlue River from its sources, in the east; and tributaries of the Black Umfolosi River, in the western portion. The elevated country is in the northern half of the area, where the Inhlwati Peak, with some points of the Makowe and Umqueme Ranges, form the highest points in the district. The south-eastern portion, which forms the Somkele coal-field, is drained by the Inyalazi River, a tributary of the Hluhlue, is lower, and slightly undulating, and is separated from the low-lying littoral by basaltic rocks, which are of considerable thickness, and form quite a number of small ranges for about five miles between the Somkele coal-field and the sandy littoral, which extends, at this point, for a distance of about 20 miles to the coast. Between the outcrop of diabase which terminates in the valley of the Inyalazi River, the coal-bearing series outcrops on the sandy littoral, as far as some miles to the south of the next store on the northern road The valley of the Hluhlue River, whose upper reaches cross this area has been denuded practically along the line of junction between the Ecca Series and the Table Mountain Sandstones, against which the former were deposited, with a very apparent unconformity, which can be readily noted in this locality.

The higher country is, as a rule, open, and free from timber or scrub, except in the river valleys, where the mimosa occurs plentifully, but widely scattered; and in the dongas and small creeks, especially when they are precipitous, thick masses of timber are present. Occasionally, as on Inhlwati Peak, the seaward aspect, which is very precipitous, is covered with dense masses of timber and undergrowth. To the west of this area, the Umfolosi River and its tributary valleys are thickly covered with mimosæ, and often heavy patches of timber with undergrowth. The tops of the ridges and plateaux are, however, quite free from timber growth, and, as a rule, are covered with kaffir kraals, these being the chief areas for the cultivation of mealies and kaffir corn. The low country, formed by the coal-measures, is usually sparsely covered with mimosæ, euphorbiæ, etc., but kraals are not

numerous over this area. A good portion of the northern part of the coal-field is included in the game reserve of the Hluhlue River. In almost all cases the surfaces of the diabase sills are entirely free from timber or undergrowth; even in the valleys traversing these extensive sills larger vegetation is rare. Over such areas kraals are not indiscriminately distributed, but collections of them occur locally in isolated positions. This is not entirely due to water supply, for basaltic areas are usually well supplied with surface waters.

Although there is a considerable difference in level between the plateau country and the less elevated country of the Somkele coal-field, there is very little of this area which is precipitous or rugged; in fact, there are few places where one cannot get about on horseback, the only difficulty with horses being the densely timbered and precipitously banked creeks, which often for miles are very difficult to cross. On the eastern and western edges of the Hlabisa plateau, the Table Mountain Sandstones present precipitous krantzes, but these are never of any great height, and there are always more or less gentle slopes by which one can ride up or down. The wide valley between the Table Mountain Sandstones of the Hlabisa plateau and the basalts of the Makowe Hills to the east, is at a considerable level below either the Hlabisa or Makowe plateaux or the top of Inhlwati Peak, to the north, but the valley is quite open, easy of access, and contains a few table-topped ranges and isolated hills of Table Mountain Sandstones. In the neighbourhood of the Umqueme Range and to the east of it, the country is mountainous, rugged, difficult of access and arduous to travel.

The whole district is exceedingly well watered, as all the main streams are perennial, and in almost all the principal tributaries, even during the dry season, a chain of large water-holes, many of them of large capacity, is always present. The Hluhlue River reserve is therefore, if the native could be kept out of it, one of the assets of the Colony, as it contains some of the best big game that this part of Africa possesses, including hippopotamus, buffalo, rhinoceros, with a small troop of the white variety, zebras, and many kinds of buck.

Representatives of the following formations have been observed as outcrops in this district:—

Granite.
Igneous Rocks of Umqueme Range.
Table Mountain Sandstones.
Ecca Glacial Conglomerate (Dwyka) and Shales.
Coal-bearing Series (Upper Eccas or Lower Beauforts).
Intrusive Diabase Rocks.
Drakensberg Lavas (possible) and Rhyolites of Lebombo Range.
Pleistocene and Recent deposits (including superficial pisolitic Ironstone).

The surface area occupied by granite is circumscribed in extent

by the overlying formations, being limited to three small outcrops, one at the northern base of Banzikazi Hill, another to the west of the Ingogong Hill, in the valley of the Uwele River, and the third on the west side of the Ungangatu Hill. In each case, the area occupied by these individual outcrops is of very limited extent, the largest of the three being that at Ungangatu Hill. A portion of this outcrop occupies a higher position than either of the other two, which are outliers in the Hlabisa plateau, showing that here, as elsewhere in south-eastern Africa, the pre-Silurian surface, composed of the granite and metamorphic rocks, upon which the Table Mountain Sandstones were deposited, was most irregular, through having undergone enormous denudation during a geologically lengthened period. The presence of these three granitic outcrops, although small in extent, is sufficient to show that the old granite, which this undoubtedly is, and which, in other parts of South Africa, has intruded the oldest known sedimentary strata, occurs over the northern portion of this district at no great depth from the surface. To a large extent the presence of the granite outcrops helps to prove the fact that the sandstones so largely developed to the east and north-east of Hlabisa belong to the Table Mountain Sandstones.

The granite is porphyritic, and the felspars are pink or grey in colour and are of fairly large size. Where it outcrops from below the Table Mountain Sandstones it is much decomposed, as is natural, where there has been an extensive unconformity. In neither of the three positions are there any metamorphic rocks associated with the granite, but the areas of outcrop are of such limited extent, that their presence could hardly be expected, seeing that, in other parts of south-east Africa, even over very large areas of granitic country, the schist outcrops are small and isolated.

The igneous rocks, which form the Umqueme Range, in the northern portion of this district, are, so far as my knowledge goes, different from the other igneous rocks of Natal and Zululand. They appear to be older than the Table Mountain Sandstones, which, with the Ecca Shales, can be seen to rest unconformably against them. They are evidently rocks of deep-seated origin, but are quite distinct from the old granite. They have not yet been microscopically examined in any detail. They are exposed also further to the north on the track to Lebombo Magistracy, 10 miles west of the latter place, and, as I mentioned in my last Report, they will probably be found still further north in connection with the granitic area in Swaziland. Between this point and the Rhyolites of the Mkusi Poort immediately to the south of the Lebombo Magistracy, there is no evidence of the presence of either basalt or diabase.

About 15 miles to the north-west of the Somkele coal-field, the country begins to rise considerably towards the Hlabisa Magistracy, which is situated on the plateau. The rise in the country is caused by the occurrence of the Table Mountain Sandstones which form the plateau, together with Ecca Glacial Conglomerate (Dwyka), which still covers the sandstones in places. In previous years when I

travelled through this country, great difficulty was experienced in distinguishing which were Table Mountain Sandstones and which were Coal Measure sandstones, because the latter attain considerable thickness and are not unlike the former petrologically. During the field-season of 1904, however, the whole country had been cleared of grass by fires, and facility was thereby given for a more accurate examination, with the result that it was possible to map the limits of the formations more or less correctly. This examination showed that the Table Mountain Sandstones are confined to the higher country, the dividing line between them and the sandstones of the coal-bearing series of the Somkele coal-field following approximately the valley of the upper reaches of the Hluhlue River.

The general feature of the Table Mountain Sandstones in the neighbourhood of Hlabisa is that they are gritty, often conglomeratic, and contain a large proportion of decomposed felspar in the form of patches of white and yellow kaolin. Their basement beds, as seen on the Ungangatu Hill to the north of Hlabisa, where they rest immediately on the granite, are pebbly conglomerates, consisting almost entirely of beautifully rounded and smoothed pebbles, of a fairly uniform size, chiefly of white quartz and quartzite, the matrix being inconsiderable. On the hillside across the river valley, to the north of Ingogong, a considerable distance above the granite, and occurring among the sandstones, is another outcrop of this well water-worn and rounded pebbly conglomerate, exactly similar to that exposed on Ungangatu Hill. An identical deposit, however, occurs immediately overlying the granitic and metamorphic rocks, and forming the basement beds of the Table Mountain Sandstones, a short distance above the crossing of the Melmoth and Nkandhla road in the valley of the Umhlatuzi River, in the western portion of Zululand. This conglomerate has frequently been erroneously mistaken for an alluvial deposit of fluviatile origin; and although, as a basement conglomerate, formed from materials derived from the underlying granitic and metamorphic rocks, which may have contained auriferous deposits, it may itself contain traces of the precious metal, deposits formed in this way have not yet proved payable in any part of the world.

The sandstones are usually thin bedded, although locally an individual bed may be of great thickness, and this outcrop is often very persistent. Shales are rarely associated with them. In places, as in the river bed to the north of Ingogong Mountain, they are of a distinctly red colour, but usually they are either grey or white, much false bedded, and of little use as building stones. They have a very slight easterly dip, but often they are apparently quite horizontal. Where the dip is increased to any extent it is generally due to the local intrusion of diabase. No traces of fossils occur in these rocks.

The country formed by this formation is typical, precipitous krantzes facing the valleys, with flat-topped plateaux and isolated hills. The physical characters of this district can be well seen from the top of Inhlwati Peak, whose southern aspect forms a perpendicular krantz of considerable height. To the west is the Table Mountain Sandstone

plateau of Hlabisa, while to the south isolated flat-topped sandstone hills occur scattered over the valley of the Hluhlue River. From this point of vantage a complete view of the whole coastal area can be obtained as far as the fringing sandhills of the coast, with Lake St. Lucia and False Bay mapped out on the flat sandy expanse of the litoral.

On the Umsindusi River, to the north of Dingetuli Hill, a good section is exposed, showing the relations of the Table Mountain Sandstones to the rocks of the Umqueme Range. A photograph of this junction is reproduced in Fig. 2, Pl. III., of the First Report of the Geological Survey. At this point the sandstones are very thin bedded, and can be seen abutting, nearly horizontally, against an anciently denuded, sloping surface of the Umqueme rock, exhibiting a great unconformity. This evidence, together with many other facts, goes to show that the rocks of the Umqueme Range belong to a series much older than the Silurian Table Mountain Sandstones. Unfortunately, the relations between these rocks and the granite, which outcrops near Hlabisa, are not apparent because the intervening country is covered with Table Mountain Sandstones and Ecca beds. It would, however, be an interesting and important point if we could discover the geological relations of the two.

The Ecca Glacial Conglomerate (Dwyka) mostly outcrops on the high ground overlying the Table Mountain Sandstones of the Hlabisa plateau; although in the bed of the Umona River, to the south-west of the Xedeni store, an outcrop occurs at a very much lower elevation. To the south of Hlabisa, again, its outcrop descends to the left bank of the Umfolosi River. No section has been cut deep enough in the coal-bearing series of the Somkele coal-field to expose the glacial deposits.

These outcrops in the neighbourhood of Hlabisa Magistracy are the furthest north representatives of the Ecca Glacial Series (Dwyka) in Zululand, and, indeed, so far as we know, on the East Coast of Africa. Although, according to Bornhardt,* "the Karroo formation appears" "near the intersection of 8° S. and 38° E., and again to the east of" "Nyasa, eastwards of 35° and about midway between 10° and 11° S.," no mention is made of the occurrence of glacial conglomerates.

The rock, as developed in this neighbourhood, is similar in character to that which occurs generally in other parts of Zululand and Natal. Were it not for the uniformity in size of the pebbles, and their roundness, the basement conglomerate of the Table Mountain Sandstones might quite easily be mistaken for an outcrop of the glacial conglomerate. On Ungangatu Hill, where the Ecca Glacial Conglomerate rests immediately on the well rounded pebbly basement beds of the Table Mountain Sandstones, this distinction can be easily studied, and the differences between the two rocks satisfactorily demonstrated. In every case the glacial rock rests immediately on

* Bornhardt, "Zur Oberflächen-Gestaltung und Geologie Deutsch-Ostafrika," Berlin, 1900.

the Table Mountain Sandstones, and never, so far as I have seen, on the granite. Recently uncovered surfaces of the sandstone show very poor and indistinct evidences of glaciation; in fact, such glaciated pavements as do occur present the most indefinite groovings. The pebbles in the conglomerate are, however, distinctly striated, faceted, and polished, and are usually of small size. Large boulders are exceedingly rare. On the Ecca glacial outcrop between Hlabisa and the point where it reaches the Umfolosi River there occur what appear to be intercalations of sandy material containing neither pebbles nor boulders, underlaid and overlaid by glacial conglomerate. They are similar to those which I described in my Second Report, p. 60, as occurring in the Ecca Glacial Conglomerate of Ulundi Plains. As in the latter locality, they are here limited in extent, and are of no great thickness. The presence of the glacial conglomerate at so many different elevations points here, as elsewhere, to the exceedingly irregular surface upon which it was accumulated, for we not only get it on the elevated plateaux, lying on the more or less flat surfaces of the Table Mountain Sandstones, but also filling hollows of some extent in the lowest parts of the neighbouring river valleys.

In those localities in which the Ecca Glacial Conglomerate (Dwyka) is still present in Zululand, the indications, the outcrops give, of the probable geographical contour of the old Permo-Carboniferous land-surface, on which the glaciation took place, are not of a very general or conclusive kind. The outcrops are isolated and limited in extent, compared with the whole area of the Province. The only two positions in which the conglomerate occurs on the coast are at the mouths of the Tugela and Matikulu Rivers. In all other cases the outcrops are at an elevation, on the uplands of the interior. Some are on the highest plateaux, as the Amazize Range, Melmoth and Hlabisa; while the others are in the valleys and even in the beds of the rivers, like those on the Upper Umhlatuzi and the White and Black Umfolosi Rivers on the Vryheid border. The nearest approach to true evidence of the old geographical contour is to be found in those positions where the glacial conglomerate still rests on the exposures of Table Mountain Sandstones, which probably formed the prevailing surface rock of the country during the Permo-Carboniferous glacial period. There is, however, evidence at the present time that, in some areas, the surface rocks, during the glacial period, consisted of granitic and metamorphic rocks. Like the Ecca Glacial Conglomerate (Dwyka), which was accumulated on the unevenly denuded land-surface of the Table Mountain Sandstones, so the latter was deposited on an unevenly denuded surface composed of granitic and metamorphic rocks, as shown by the great unconformity between them. This accounts for the different levels at which the Table Mountain Sandstones are to be found, on the high plateaux and on the sea coast. As the sandstones are almost always horizontal, and faulting is rare, the individual beds exposed at these different altitudes are probably over 1,000 feet apart in

stratigraphical position. That this is so can easily be seen in the Melmoth district, where the sandstones, to the south of the township, are of no great thickness, and at a high elevation, while passing down the valley of the Imfule River, to the east of Melmoth, there is a continuous descending series of Table Mountain Sandstones of over 1,000 feet in thickness. So it is with the Ecca Glacial Conglomerate (Dwyka); although not a bedded deposit, it was, on the melting and retreat of the ice-sheet, accumulated at many different levels on the unevenly denuded land-surface, which was chiefly composed of Table Mountain Sandstones and occasionally of granitic and metamorphic rocks. Since the accumulation of the Ecca glacial deposits (Dwyka), large areas of Table Mountain Sandstones and granitic rocks have been laid bare by denudation, and there is no doubt that the exposures of these rocks, which do not now carry outcrops of Ecca Glacial Conglomerate (Dwyka), have undergone so much denudation, since the elevation of the southern part of the Continent in Mesozoic times, that even if the superposed, now denuded beds of the Table Mountain Sandstones had borne glacial deposits (Dwyka), there is little evidence left, on the sandstone outcrops, of the geographical contour of the old glacial land-surface. In cases where the glacial deposit is still present on a portion of the old land-surface, it gives us a clue to a wide generalisation as to the probable glacial contour. From the distribution of the outcrops still present, it would seem that the glacial land-surface was of a type much resembling the land-surface of the present time; that is to say, that the high ground of the uplands was at a generally uniform level, similar to what exists to-day, and the whole surface had a general slope to the eastward. The country was undoubtedly higher than it is at present, because, along the coast, the terrestrially formed glacial deposits outcrop freely on the sea shore, with the certainty of the occurrence of these deposits for some distance out, on the present sea-floor.

The coal-bearing series of the Hlabisa district, including the Somkele coal-field, is an extension of the Intambanana coal-field northwards across the valleys of the Black and White Umfolosi Rivers, near their junction. This large area of coal-bearing strata, stretching from the valley of the Umhlatuzi River, some miles to the north of Eshowe, as far north as the Hluhlue River valley, is separated in the west from the *Glossopteris*-bearing series of shales in the Mahlabatini and Nongoma districts by the Table Mountain Sandstones, which outcrop almost continuously between Melmoth and the Hlabisa plateau. On its southern boundary it is separated from the coal-bearing series of the Umlalaas River valley by the Table Mountain Sandstones, granites, and metamorphic series of the Engoye mountain range.

In Zululand we have, therefore, three isolated basins of coal-bearing strata. The Umlalaas River basin lies between the coast and the granites of the Engoye Mountains. The Intambanana and Somkele basin lies between the granites of the Engoye

Mountains and the Table Mountain Sandstones of the Melmoth and Hlabisa districts. The Mahlabatini and Nongoma basin lies between the last-named sandstones and the granites of Swaziland. The palæontological evidence, which the plants from the shales in these three basins have yielded, proves that they were formed during the same geological period. The Umlalaas River basin was completely isolated from the other two, but there may have been a slight connection between the two northern basins, in the region where the Black Umfolosi River has cut through the Table Mountain Sandstones to the south of Hlabisa. For all practical purposes they may be considered as three individually isolated basins. As regards the occurrence of coal in them, each basin will require to be taken upon its own merits, that is to say, that the sequence of beds and the number of seams of coal, with their positions relative to the prominent members of the strata, will not necessarily be the same in the three basins, and therefore the geological data which lead to the tracing of a coal seam in one of the basins will not apply in the others.

I think, however, from what little we know regarding the sequence of beds in each of these three basins, there is no doubt that the coal seams occur at a considerable distance (a few hundred feet) above the glacial conglomerate in all three, although, to the north of Hlabisa, *Glossopteris* leaves occur fairly low down in the shales; certainly at a much lower horizon than the coal seams, either at Somkele or Nongoma. Under the circumstances obtaining in the Zululand coal-bearing series, the accurate record of bores drilled in this series is of the greatest importance. I should think that more boring has been done in the Umlalaas basin than elsewhere, but here the strata are often found to dip at various angles, and the surface of the country is undulating; but these facts have not been taken into account, as no correlations have even been attempted of the superficial beds among which the various bores started. This in itself is a most important point, under the circumstances I have mentioned above, to give a practical and otherwise useful and permanent value to the geological knowledge which the bores should have furnished.

So far as I have observed, there is only one position where the relations of the Ecca Series to the rocks of the Umqueme Range, which have a distinctly plutonic character, can be clearly demonstrated. About a mile to the north of Dingetuli Hill, a small outlier of Ecca Shales is exposed in a donga, which is close to the junction of the latter rocks with those of the Umqueme Range. The shales are undoubtedly the blue-black glacial shales of the lower Eccas, and are quite horizontal in the donga, while the Umqueme rocks form the hill rising immediately from the donga, to the north. The shales have evidently been laid up against the latter rocks with a considerable unconformity, and it is quite apparent that there is no faulting in the immediate vicinity.

In the creek valley to the south of Dingetuli Hill another

interesting occurrence takes place. In the first creek bed to the south of the hill, and between it and Isondwane Hill, an outcrop of grey shales occurs, dipping steeply to the south-east. A short distance down this creek on its southern bank, where it is joined by the tributary from the eastern side of Dingetuli Hill, finely laminated black shales with hard ferruginous bands outcrop, resting on the Ecca Glacial Conglomerate (Dwyka), which is here exposed over a limited area. In the creek bed immediately to the south of Isondwane Hill, which partly consists of Ecca Shales and partly of Table Mountain Sandstones, an outcrop of Ecca Glacial Conglomerate, of some extent, is exposed. On the southern slope of this creek, between the latter and the old main road from Nongoma to Makowe, it again outcrops, while to the south, all the other outcrops are on the Hlabisa plateau, with the exception of the Umona creek exposure, thus showing the differences of level at which these glacial deposits occur.

In most of the areas on the Hlabisa plateau occupied by Ecca Glacial Conglomerate (Dwyka), there are few positions in which the Ecca black shales are present overlying the conglomerate. About a couple of miles south of the Xedeni store the black shales are present, containing indistinct but undoubted traces of *Glossopteris* leaves, while in the valley of the Umona River to the westward the glacial conglomerate outcrops for some miles along the river bed. Another occurrence of this is to the south of Isondwane Hill, where the black shales are seen immediately overlying the glacial conglomerate, but here they do not contain any fossil remains. These black shales also occur as a small outcrop about a mile to the north of Dingetuli Hill, where they rest unconformably on the igneous rocks of the Umqueme Range. In this case there is no evidence of the presence of the Ecca Glacial Conglomerate (Dwyka) in this locality. The northern boundary of the conformable series of sedimentary beds which contain the Somkele coal-measures, abuts, in the Hluhlue valley, chiefly against Table Mountain Sandstones, and in two positions only, overlies the Ecca Glacial Conglomerate, whose outcrop at this boundary is at a much lower level than those on the Hlabisa plateau. The two positions in which the shales occur overlying the glacial conglomerate are, the one to the east of the Usemu Hills, and the other to the south-west of Hlabisa on the Umfolosi River. All along this boundary the shales are non-fossiliferous, but have the characteristic petrological characters of the Ecca glacial black shales. They lie practically horizontally, and on the rising ground of the southern watershed of the Hluhlue River, towards Somkele, the beds overlying them are also horizontal. This is typical of the whole outcrop from the basaltic rocks of the Makowe Hills westward to the Umfolosi River. Within a mile or two north of the Somkele coal outcrop these beds suddenly dip to the south-east. So far as investigations have gone there is no evidence of the presence of a fault to produce this dip, and the higher beds containing the coal-bearing series, brought into the section by the dip, are not represented among the horizontal

strata, between the position where the dip commences and the boundary of the Ecca Shales to the north, where they abut against the Table Mountain Sandstones and the Ecca glacial deposits (Dwyka). This dip of the strata is confined, locally, to the neighbourhood of the Somkele township, and does not occur further to the south-west, towards the Umfolosi River, than the road between Somkele and Hlabisa. It, however, persists to the south-east between Somkele and the basaltic rock to the south. In this area the dip of the beds can be seen in the dry dongas and creeks as far east and south-east as the coal-bearing series is exposed. Away to the south-west, in the country drained by the lower parts of the Black and White Umfolosi Rivers, as far east as the basaltic rock, the coal-bearing strata are perfectly horizontal, except for occasional local intrusions of diabase sills and dykes, which are, however, comparatively rare.

The coal-bearing series outcrops over quite half of the southern and north-western portions of this area. So far they have only proved to be productive in the south-eastern part of the district, near the township and railway station, now called Somkele, and formerly known as the St. Lucia coal-field. In this locality there is, as yet, only one mine that has been developed to any extent. Other outcrops of coal, however, occur in the Somkele coal-measures, chiefly to the south-west of the township towards the Umfolosi River. These are mostly natural exposures in the dongas and creek beds, but none of them have been opened up sufficiently to enable one to conclude as to whether they may be of economic value or not. The following are a few of the localities in which outcrops are exposed :—On the Amaenga creek, in the dongas of two of the northern tributaries of the Umcacaza creek, with two outcrops in the bed of the main Umcacaza creek, to the east of Inciba Hill.

With regard to the Somkele coal-mine, now being worked, Mr. E. D. Reynolds has kindly furnished me with the particulars which I incorporate below.

The series of shales in which the coal seams occur is nearly 50 feet in thickness, of which there are over 30 feet of coal in various seams. The dip of the strata is about 22° to the eastward. Two inclined shafts have been sunk on two of the more important seams, one near the bottom of the series of shales and the other near the top. These shafts have been connected at the 400 feet level, and have been continued on the dip to the 600 feet level. Levels have been driven at intervals from the main inclines. The coal is semi-anthracitic and the ash varies, but there is the probability that the percentage of ash may be reduced by washing, and Mr. Reynolds informs me that a plant for this purpose has been sent to Somkele. Altogether about 20,000 tons of coal have been mined up to date. Most of this has been taken out in development work, with a small plant, which is now being enlarged. The neighbourhood of Somkele is exceedingly poorly watered, but a large reservoir, estimated to conserve 6,000,000 gallons of water, has lately been constructed in the vicinity of the mine.

It is a well-known fact that so far as investigations have gone the bulk of the coals in Zululand have been found to be anthracitic and semi-anthracitic in character, and there are very few bituminous coals that can be worked profitably. The Somkele coal is semi-anthracitic. It is, therefore, difficult of ignition, and does not burn well in ordinary grates, or in boiler fires, such as are in existence in Natal, which have been fitted for the burning of bituminous coals only. Notwithstanding the deficiencies in the fittings of the local grates and boilers, this coal is largely used in Durban, and even at East London in Cape Colony, generally mixed with a percentage of one or other of the Natal bituminous coals from the northern coal-field. This result has been obtained by the extensive experiments that have been carried out at Somkele, with a view to testing the quantities and qualities of other Natal coals (bituminous) necessary to produce a freely burning mixture in ordinary grates and for ordinary uses. This disadvantage, caused by the initial disability of a ready ignition, has been a considerable detriment to the exploitation and working of these anthracitic coals, which occur over a large portion of Zululand, and it is one which should have been removed long ago by Government experiment; for it is by no means an insurmountable difficulty to make anthracitic and semi-anthracitic coals as useful and profitable as bituminous coals. In America and elsewhere they are used for all kinds of purposes in place of bituminous coals, but in these cases the mechanical appliances for their combustion and uses have been modified from the ordinary fittings employed for more readily burning coals.

With regard to the whole question of coals, the most economical, efficient, and profitable methods of using them, great advances have within late years been made by various Governments, through their scientific officials, in arriving at valuable conclusions from experiments as to the best methods by which, according to their chemical composition, &c., they can be utilised so as to bring out their individually important, useful, profitable, economic possibilities.

In the United States of America the Government have, for a number of years, since the St. Louis World's Fair, added a staff of scientific men to the Geological Survey for the purposes of coal-testing. That this subject has become a most important national factor, in the economics of coals produced within the limits of the country, is now patent to everyone who takes a scientific view of the application of scientific methods to even the burning of coal. The Director of the Geological Survey has recently had published the first comprehensive report containing the results of the investigations so far as they have been carried out. As might be expected, it is a voluminous report, but a few of the main and more important conclusions arrived at are given below. The initial point, of course, has been that, under an Act of Congress, an appropriation of $200,000 has been made to cover the operation of the plant up to the 1st of July of the present year. There was also a provision that the cost of transportation of the coal-samples should be borne by the

producers furnishing them for test purposes. In the United States of America this is quite right, as the railways, as a rule, are held by companies. Many of the conclusions which have been arrived at are of the most important character. From a broad point of view, it is believed that the development of the steam power produced through the consumption of coal, in consequence of the more efficient methods suggested by these investigations, will mean the saving of many millions sterling to the American manufacturers.

Some of the conclusions given in this report are as follows:— (1) When coal is converted into gas and used in a gas engine, its average efficiency for power purposes is from 100 to 150 per cent. greater than when used under boilers. (2) The poorer grades of coal, rated according to their steam-raising qualities, give better results in the gas producer than the higher grades of steam coals. (3) Lignites used in the gas producer, in power-raising efficiency, are equal to or better than steaming coals used under boilers. (4) Many coals high in sulphur or ash can be materially improved for steaming, coking, or briquetting purposes by washing. (5) Some non-coking coals can be made to produce a fair quality of coke by an addition of coal-tar pitch to the charge of coal. (6) Much has yet to be learned concerning the economical use of coal and the best methods of mine sampling for analytical determinations. One of the most important results so far has been in reference to producer gas. "The tests have demonstrated that bituminous coals and lignites can" "be used in the manufacture of producer gas, and that this gas may" "be consumed in internal combustion engines for the development" "of power, with a fuel economy of over 50 per cent. It is further" "shown that the power producing effect of a given weight of a" "number of bituminous coals, when converted into gas and used in" "a gas engine, is 2½ times as great as it is when used under boilers" "for steam power, *i.e.*, one ton of coal in the one case is equivalent to" "2½ tons in the other. Results in the same direction were obtained" "with lignites, and it is shown that certain of the dry, non-coking," "bituminous coals and semi-anthracites, which are now almost" "wasted, can be converted into useful fuel by briquetting."

That these conclusions from the preliminary stages of the coal-testing investigations will produce far-reaching results in the future, there is little doubt. The gas engine as a propelling power is every day coming into more common use, and if, as seems not improbable, it takes in the future the place of steam boilers and engines in the largest steamships, the saving in the cost of coal would be considerable, and, what is perhaps more important, the distance travelled without the necessity for coaling would be greatly increased. With regard to the generation of power, the coal-testing plant has shown the following result: that the saving by the producer and gas engine is more than 50 per cent. when compared with the generation of power by the boiler and steam engine; and in one case the amount of coal consumed per horse-power per hour by the boiler plant was nearly three times that used in the producer.

The reason I quote the above results from experiments in the United States of America is to call the attention of the Government to the fact that a great deal could be done to ensure the more economic uses of coals, by which the price would not only be reduced, but the more efficient utilisation of individual coals of different composition, &c., would be secured.

There are two horizons in the coal-bearing series of Somkele from which I have obtained fossils, chiefly plants, with, in one case, fish remains. The one is a short distance above the coal now being worked, and the other is considerably below it. The former locality is about half a mile south-west of the Somkele coal-mine, towards the junction of the northern with the Hlabisa road. The rock is a drab coloured clay shale, from which the fossil specimens were taken. The descriptions of the plant remains by Mr. R. Etheridge are recorded at p. 69 of the First Report of the Geological Survey of Natal and Zululand.

The list is as follows :—

Glossopteris Browniana, var. *Indica*, Bunbury.
Glossopteris Browniana, var. *angustifolia*, Brong.
Glossopteris damudica, var. *stenoneura*, Feist.
Glossopteris retifera, Feist.
Glossopteris acuta, Dun.
Glossopteris spathulo-cordata, Feist.
Phyllotheca Zeilleri, Eth. fils.
Angiopteridium spathulatum, McClelland.
Estheria Greyii, Jones.

The fish remains from the same locality, associated with the above plants, are mentioned by Dr. A. Smith-Woodward at p. 101 of the present Report.

The other locality from which I have obtained fossil plants is in the bed of the Enseleni creek, at one of its large bends to the south of Ingula Hill, about a mile to the north of Somkele township. I first heard of this locality from Mr. J. Tweedie, Victoria County, Natal. The shale outcrops were very prolific in specimens of *Glossopteris* leaves, some of which were of great size, but this collection has not yet been described. Associated with the fossiliferous shales at this locality there occurs an impure limestone, one of the few calcareous beds I have met with belonging to the Lower Karroo, with the exception of a limited outcrop mentioned in my Second Report at p. 57, and the calcareous rock discovered by Mr. J. J. Garrard in the vicinity of Somkele's kraal, between the coal-field and the Umfolosi River, to the east of the main road. Neither the last mentioned calcareous rock nor that on the Enseleni creek shows any traces of fossils, but neither of them has been sectioned for microscopical examination. The limestone, however, mentioned in my Second Report, outcropping about 15 miles to the south-west of the Umfolosi River, on the track from the old Magistracy to Melmoth,

contained what appeared to be indistinct casts of Mollusca, but they were not sufficiently clear for identification. The few isolated outcrops of this rock which were met with seemed to be *in situ*, among the sandstones and shales of the coal-bearing series. Of these calcareous beds, the only one which might prove of any economic value is that on the Enseleni creek, but this would need extensive quarrying, and the percentage of impurities is large.

The series of shales intervening between the Glacial Conglomerate (Dwyka) and the coal-bearing series of Natal, Zululand, and Vryheid, vary much in thickness in different localities. This is particularly the case as regards the lower shales, the glacial muds, overlying unconformably the Ecca Glacial Conglomerate, which in very many localities are not present at all between the Palæozoic, Metamorphic and Plutonic rocks of the Permo-Carboniferous land-surface and the shales and sandstones which comprise our coal-bearing series. This fact is quite what one would expect to find, taking into consideration the conditions under which these glacial muds were deposited in the irregularities of the land-surface after the retreat of the ice-sheet, sometimes on the top of the morainic débris which now forms the Ecca Glacial Conglomerate (Dwyka), and sometimes on the older rock outcrops of the land-surface, without the intervention of the glacial conglomerate. According to the local supply of glacial mud, it was deposited in the irregularities of the surface to a less or greater depth, as the case might be. On the other hand, large areas formed of the older rocks had no deposition of these muds upon them at all. Where the superimposed series of the shales and sandstones of the coal measures rest on the glacial muds, they form a conformable series with them, and there is little doubt that, where fossiliferous, they contain the remains of the earliest flora which made its appearance after the close of the Permo-Carboniferous glacial period. It is no uncommon thing to find that the whole series of shales, the glacial muds, and the light drab-coloured shales intervening between them and the sandstone coal-bearing series, in many places are hardly recognisable, while in others they are some hundreds of feet in thickness. It is therefore evident that no single section of the shales intervening between the glacial conglomerate and the coal-bearing series can be made a criterion as to how many actual feet of Ecca Shales represent the total period between the retreat of the ice-sheet and the deposition of the coal-bearing series. In Cape Colony it is different, because, over the south, the beds form a conformable series of sedimentary strata from the Palæozoic systems through the Permo-Carboniferous glacial deposits, Ecca and Beaufort Series up to the Upper Karroo, thus giving practically a uniform thickness of strata to represent any portion of the periods involved. In the case of the Somkele coal-field there is a considerable thickness of shales between the glacial conglomerate and the coal-bearing series. The shales from which I have obtained fossil plants, in the bed of the Enselene creek, are some distance stratigraphically below the Somkele coal, while the other fossiliferous shales, referred to some pages back, are a short distance above the

coal seam, but, as is usual elsewhere, the lower shales overlying the glacial conglomerate are not fossiliferous.

In the western part of Natal, along the base of the Drakensberg, we have the Beaufort Beds strongly developed. At one locality on the Umkomazan River they have been recognised by Dr. Broom to belong to the Middle Beauforts of Cape Colony. They contain abundant Reptilian remains, such as *Lystrosaurus* and *Dicynodon*, &c. Between this series of Middle Beauforts and the Ecca Shales immediately overlying the glacial conglomerate, outcropping in the valley of the Umkomaas River, between the Deepdale bridge and the crossing of Richmond to Ixopo road, there must be a very great thickness of strata, certainly containing a good deal of intrusive diabase, which represents the Lower Beauforts and the Ecca Shales. In the series at Pietermaritzburg, the sandstones which appear to occupy the coal-bearing horizon are at least 1,500 feet above the glacial conglomerate at the Little Imputshini River, between the city and Thornville on the old Durban road. Unfortunately, most of the shales in Central Natal have so far proved to be quite unfossiliferous. The presence of an isolated specimen of a Tæniopterid, *Angiopteridium spathulatum*, McClelland, among the *Glossopteris* flora of the Somkele coal-field is not, to my mind, a strange fact, or one which could be reasonably used to prove the younger age of beds, the bulk of whose fossil flora consists of *Glossopteris* individuals. That a conclusion of this kind should be drawn is no nearer the mark than that an analogous conclusion might also be arrived at that the Molteno Beds of the Stormberg Series are much older than they are supposed to be, with a *Thinnfeldia* and *Tæniopteris* flora, because of the presence of a few odd specimens of *Glossopteris* among them. I have myself collected imperfect specimens from the sandstones overlying the coal at Wolff's Mine, Molteno district, which bore the closest resemblance to the genus *Glossopteris*, but they were little else than mere casts. The outline of the leaves was, however, quite distinct, and the characteristic anastomosing venation was quite recognisable. Mr. Arber,* in his catalogue of the *Glossopteris* flora, p. 61, also mentions the fact that the British Museum contains specimens of *Glossopteris* from Vice's Mine, which is close to the township of Molteno, and is on the same geological horizon as Wolff's coal-mine, among the Molteno Beds. In Permo-Carboniferous times the *Glossopteris* flora prevailed, while the *Tæniopteris* flora reached its maximum development in Triassic and Jurassic times. Mr. Arber states, in his introduction (p. xxvii): "In the Palæozoic" "beds of both Europe and North America, as of Gondwanaland, we" "seem to see the first incomings of races of great importance at later" "geological epochs, but not specially characteristic of the period" "at which they first appear. *Tæniopteris* is a case in point." In the same work the author writes: "*Tæniopteris* is essentially a"

* Arber, E. A. N., "Catalogue of the Fossil Plants of the *Glossopteris* Flora in the Department of Geology, British Museum (Natural History), being a monograph of the Permo-Carboniferous Flora of India and the Southern Hemisphere," 1905.

"Mesozoic type of frond, in that the genus reaches its maximum" "development in Triassic and Jurassic times, and extends to the" "Lower Cretaceous period. It makes its first appearance, however," "in the higher horizons of the Upper Carboniferous, and in the" "Permian rocks of Europe and elsewhere in the Northern Hemi-" "sphere, as well as in the Permo-Carboniferous beds of India," "?Australasia, and South Africa." Mr. Herbert Kynaston,* in a recent paper "On the Geology of the Neighbourhood of Komati Poort," makes the statement that "no Tæniopterid forms are as yet known in South" "Africa from a lower horizon than the Molteno Beds," but in the above quotation Mr. Arber states that it occurs in the Permo-Carboniferous beds of India, ?Australia, and South Africa. So that the presence of *Tæniopteris* is not alone sufficient to prove the beds Upper Karroo.

Draper's † idea of the contemporaneity of the *Glossopteris* flora which is typical of our coal-fields with the *Thinnfeldia* and *Tæniopteris* flora of the Upper Karroo Series has not been borne out by later investigations, although I think he is right in the statement that to the north-east of the Drakensberg the whole series of the Upper Karroo thins out. At the same time it does not seem possible that the difference of level or climatic conditions could in so short a distance have produced a *Tæniopteris* flora over the area of the Drakensberg west of Natal, and a contemporaneous *Glossopteris* flora in what are now the Newcastle and Dundee districts, the Vryheid district, and Zululand.

So far I have seen no evidences, stratigraphical, petrographical or palæontological, of the presence of either the Molteno Beds, Red Beds or Cave Sandstones in any part of Zululand or the Vryheid district, and I think it is extremely doubtful if we have any Karroo rocks higher than the Beaufort Series, except perhaps the Lebombo Rhyolites of Northern Zululand. Red, purple and other highly coloured shales outcrop through the basalts on the Umsindusi River, about five miles to the west of Lake Isitesa, to the south of Somkele. They form a small outcrop, but so far as I could make out there was no reason to suppose that they were representatives of the Red Beds of the Upper Karroo Series, because they are entirely unfossiliferous, and similarly coloured shales are of common occurrence among the Beaufort Beds of Cape Colony. In the bed of the first tributary of the Enseleni River, to the east of the northern road, close to Somkele township, beds which evidently overlie the coal-measures show up more or less highly coloured, but there is absolutely nothing to indicate that they belong to the Red Beds of the Upper Karroo Series of the Drakensberg.

I have all along appreciated the fact that in dealing with the age of the coal-bearing series of Natal and Zululand, the chief difficulty was as to which of the two divisions of the Permo-Carboni-

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* Trans. Geol. Soc. S. Africa, vol. ix., p. 30, 1906.

† Draper, D., "Notes on the Geology of South East Africa," Quart. Journ. Geol. Soc., vol. l., p. 553, 1894.

ferous period, the Ecca or the Beaufort Series, these coal-bearing beds belong. It must be admitted that the *Glossopteris* flora is characteristic of both the Ecca and Beaufort Series, but the prevalence of fossil reptilian remains is not a feature of the Ecca Series, although *Mesosaurus* occurs in the latter beds at Kimberley, in Cape Colony. The Beaufort reptilian remains are found at a much higher horizon than that at which our coal series occurs in Natal, Zululand, and the Vryheid district, as I have already mentioned some pages back.

With regard to this point as to whether our coal-bearing series is of Ecca or Beaufort age, it means that we have, with our present meagre palæontological knowledge of these two series, to say whether the beds overlying conformably the Ecca glacial mud deposits, which in age immediately succeeded the glacial period, are to be included in what is known as the Lower division of the Beaufort Series of Cape Colony, or whether this conformable series, including our coal-measures, is to be recognised as contemporaneous with the *Glossopteris*-bearing Ecca Series of Cape Colony. We have therefore to include this series, from the black glacial shales, with our coal-measures, either in the reptilian Beaufort Series, of the base of the Natal Drakensberg, or we have to find a palæontological division between the latter reptilian series (known Beauforts with no coals) and the coal-bearing series of Natal and Zululand which I have included in the Upper Ecca Series. This palæontological division seems to me to be fairly well indicated by the non-occurrence among our coal-measures and underlying beds of the remains of those reptiles which are so characteristic of the Beaufort Series.

It is probable that at Vereeniging, Middelburg, and other places in the Transvaal, we have fossiliferous coal-bearing beds, at a lower horizon than any of the fossiliferous coal-measures of Natal, Zululand, or Vryheid district, because we find Palæozoic forms such as *Sigillaria*, *Bothrodendron* among the *Glossopteris* flora of these coal-bearing beds which immediately overlie the glacial conglomerate. I do not think there can be any doubt as to the age of these coals being Ecca, and probably low down in that series. There is no question about the fact that our coal-bearing series is stratigraphically some hundreds of feet above the Ecca Glacial Conglomerate, but, as I have previously stated, the thickness of strata between these two is most variable in different localities over the area east of the Drakensberg.

I do not think that, owing to our exceedingly scanty knowledge of the palæontology of our representatives of the Karroo system, we are justified, at any rate as yet, in including our coal-measures, with their underlying series of shales, among the reptilian Beaufort Beds, merely because of the occurrence of a few isolated specimens of plant remains of a Mesozoic type among our small collections. I see no reason for altering my idea that the coal-bearing series of Somkele and the other coal-measures of Natal and Vryheid district, together with the shales overlying the Lower Ecca glacial muds, should be

included as Upper Eccas, at least until satisfactory stratigraphical and palæontological facts are produced to conclusively prove that the Beaufort Series starts below the coal-bearing beds.

The diabase rocks are in all cases intrusive, and are more prevalent to the north and east of the Hlabisa and Somkele districts. In the coal-bearing series to the west of Hlabisa they are also of frequent occurrence. They are rarely seen intruding either the Table Mountain Sandstones or the Ecca Glacial Conglomerate (Dwyka), while almost in any district it is exceedingly rare to find diabase intruding the granite. In this area the outcrops of the granite are of small extent and show no intrusions of diabase. Two rather large patches of diabase occur on the Table Mountain Sandstones, one on the road between Hlabisa and the Xedeni store, and the other immediately to the south-west of Hlabisa. One or two small outcrops occur in the Hluhlue valley, about two miles east of the Somkele and Hlabisa road. The country to the north of Somkele, including the Makowe and Iqoqoqu Hills, is formed almost entirely of basaltic rock, the outcrops of shales and sandstones being very thin and separated superficially by wide distances.

It is possible that, to some extent, portions of the basaltic rocks which overlie the Somkele coal-measures to the south, and form the Makowe Hills to the north, may represent the Drakensberg Jurassic lavas, as has lately been suggested by Mr. Kynaston, in a paper "On the Geology of the Neighbourhood of Komati Poort," read before the Geological Society of South Africa on March 12, 1906, and by myself, First Report, p. 61. The basalts to the south of the coal-field extend across the Umfolosi River as far to the south as the Lower Umfolosi Magistracy. To the west of the Magistracy and at the Patane precipice on the Umfolosi River they have a decided dip to the south-east. At the latter place they are some hundreds of feet in thickness, and consist of a number of distinct layers with intervening amygdaloidal layers, and therefore have here all the appearance of a series of lava flows. Those of the Hluhlue River valley and the Makowe Hills are not amygdaloidal, and thin series of sandstones and shales are frequently met with among them, just as occur among the intrusive basalts of the Ladysmith and Impendhla districts of Natal, where large areas of these intrusive rocks are exposed at the present surface. On the Umsindusi River, a tributary of the Mkuzi, where the former passes through the Rhyolites of the Lebombo Range, both the basalt on the flat country to the west of the range and the Rhyolite are intruded by a comparatively fresh basaltic dyke, of no great thickness. The diabase sills which have been intruded among the coal-measures at Somkele are often of considerable thickness. In one of the bores put down by the Somkele Coal Company, a sill of over 400 feet in thickness was passed through. Such dykes as have yet been encountered among these strata have not proved to be of sufficient thickness to be of much importance.

In many parts of this district, particularly to the north-east of Hlabisa, superficial deposits of pisolitic ironstone occur. They are, in

all cases, of secondary origin, and therefore are somewhat earthy, containing a large amount of impurities. Of the samples analysed the iron oxide percentage varied from 27·4 per cent. to 58·8 per cent. The analyses of seven samples, from different localities, analysed at the Government Laboratory, Durban, are given below:—

	1 Per cent.	2 Per cent.	3 Per cent.	4 Per cent.	5 Per cent.	6 Per cent.	7 Per cent.
Iron oxide	53·7	27·4	55·5	47·2	58·8	47·1	51·1
Aluminium oxide	4·5	1·6	6·5	6·4	3·3	0·7	4·6
Insoluble residue	33·1	64·1	26·8	34·1	27·2	33·8	32·7

Some of these deposits are of considerable extent, but as a rule are not of great thickness. They are indicated on the accompanying map of the district (Plate XXI.).

It is a well-known fact, among the early European traders who are still alive and the older natives, that this district was one of those famous for the production of iron, from which assegais and other weapons were manufactured. I have not come across any evidences of old workings, nor of the remains of native smelting furnaces, but it is, I think, more than probable that the iron ore used was taken from these superficial pisolitic deposits, as was the case in many districts in India where the ancient manufacture of iron was carried on by the natives.

The quartz and quartzite outcrops are local in their occurrence, and usually form lengthened ridges of a rugged description, which are a characteristic feature of the scenery of this district. They have, with few exceptions, a general strike from north-east to south-west. Some of them are extensive, outcrop for miles, and have a considerable elevation, particularly that which forms the Bombolu Mountain and others in that neighbourhood. The quartz outcrops are all in the form of reefs. In the case of the quartzite outcrops, some of them appear to be faulted. The westerly side of the Bombolu Mountain quartzite shows an almost perpendicular slickensided face, rising to a considerable height. In many cases, such as Inkoyamane and Umteku Hills, the quartzite ridges appear to outcrop through the basaltic rock, as if they had been surrounded by a lava sheet, and subsequently exposed by denudation. In most cases they have been tried in a cursory way for the presence of ores of metals, but with very poor results.

NOTES ON THE GEOLOGY

OF THE

DRAKENSBERG RANGE,

NATAL.

NOTES ON THE GEOLOGY OF THE DRAKENSBERG RANGE.

The Kahlamba or Drakensberg Mountains, forming the western boundary of Natal, are mountains of denudation, and are a magnificent example of subaerial erosion. Their Natal aspect presents the denuded eastern edge of the plateau of the high feld, which forms the major portions of Basutuland, Orange River Colony, and the southern Transvaal. The Range, as a range, only appears so from the eastern Natal side, because the denudation caused by the Natal rivers, the larger and more important of which have their sources in the neighbourhood of the slopes of the Drakensberg, has lowered the level of the whole country from the Drakensberg border to the sea-coast. The physical geology of the country has lent itself admirably to this, inasmuch as the strata forming the western half of the Colony consist chiefly of shales, with sandstones and occasional basaltic intrusive rocks, which are usually local in occurrence. Nearer the coast the granite, metamorphic rocks and Table Mountain Sandstones might have offered an obstruction to the denudation, had it not been for the fact that the last-named formation was of comparative thinness and rests unconformably on the granites, through which erosion is fairly easy. The rivers have thus cut through the outcrops of the various geological formations nearly at right angles, and the result has been that the surface of the country has been formed into a series of plateaux, from the sea-coast to the Drakensberg Range, the top of which forms the highest plateau.

At the point where Basutuland joins Griqualand East the main Drakensberg Range bends south-westward and passes into the Transkeian Territory; but from the point mentioned a subsidiary range of comparatively low elevation passes along the boundary between Griqualand East and Natal, terminating in the Ingeli mountains, which consist almost entirely of intrusive basaltic rocks with scanty outcrops of Ecca shales among them. In fact, near the source of the Ibisi River outcrops of Ecca Glacial Conglomerate (Dwyka) occur. Away to the north, where the Range forms the boundary between Natal and the Orange River Colony, and where it terminates in the southern Transvaal, the general elevation is much lower, and, as shown by the frequency of passes, it is much more accessible and does not present any great difficulties to the climber. Even the more or less isolated peaks are quite easily climbed. As far as the northern point of Natal, at Majuba Hill and Langs Nek, the Upper Ecca coal-bearing rocks

form the Range, with the usual intrusions of basaltic rocks. From near this point the Range divides into two, one portion passing towards Standerton and the other to the east, towards Piet Retief.

The rocks forming the Natal slopes of the Drakensberg and many of the foot-hills for 40 or 50 miles from the main Range lie practically horizontally, and in descending order are as follows :—

Upper Karroo	Amygdaloidal Basaltic and Rhyolitic Lavas.
	Cave Sandstones.
	Red Beds.
	Molteno Beds.
Lower Karroo	Beaufort Series.
	Ecca Series (not including the glacial conglomerate).

So far as is at present known, there is no unconformity between any two of these divisions of the Karroo system in Natal, with, of course, the exception of a slight unconformity between the Cave Sandstones and the Jurassic lavas. Representatives of all these series are not always present in every section exposed on the face of the Drakensberg slopes and the foot-hills. On that face of the Berg overlooking the Upper Tugela, probably the whole series are represented, for at the township of Bergville, fossils (*Glossopteris*, *Phyllotheca*, &c.) are present in blue-black shales resembling those of the Ecca Series. This is, of course, including the isolated mountains intervening between the Berg proper and the Magistracy. Taking the Berg at other points, to the west of Underberg or Himeville, no rocks older that the Beaufort Series occur, and this is the case nearly as far north as Giant's Castle. To the west and south-west of Newcastle the coal-bearing series of the Upper Eccas is present. The non-existence of the Upper series is in all cases due to denudation, but in the case of the absence of the outcrops of the Lower series it is due to the fact that denudation has not gone deep enough, through the overlying strata, to expose them.

In the Beaufort Beds of Mooi River district, and on the Umkomazan River, the fossil bones of Reptilia, such as *Dicynodon*, &c., occur fairly plentifully. In many localities, in the strata of the upper portions of the foot-hills, as the Macquaqua Mountain at Bulwer, and of the lower portions of the Berg proper, the fauna of the Stormberg Series (*Thinnfeldia*, &c.) is distinctly recognisable. The Cave Sandstones and Red Beds have as yet been investigated only in a very cursory manner, but the fossil remains, although of a most fragmentary kind, point to the identification of these series as being present in the upper portions of the Drakensberg Range. The beds of sandstone in all these series, with, perhaps, the exception of the Eccas, from their occurrence among shales of a most friable and easily eroded character, have lent themselves to the formation of cave-shelters quite naturally. The hollowing out of the shale beds underneath a series of overlying sandstones is originally caused by the natural agents of aerial denuda-

tion. This natural excavating has been, no doubt, accelerated and the hollow enlarged by the frequent presence in it of the natives who had taken shelter there, until, as we find at the present day, when they are no longer used for the purposes of shelters, the hollows are large excavations with a sandstone roof and often walls partly sandstone and partly shales, or entirely sandstone. It is no uncommon thing to find that the walls and roof are covered with sketches of animals which can be identified, and also with pictorial representations of episodes (chiefly hunting) in the life-history of the people who were the artists. In many cases I have seen such artistic efforts represented on smooth joint-faces of variously coloured shales, but in the majority of cases the native artist, as in Australia, preferred sandstone as his painting surface. In the Drakensberg and the low country to the east these paintings are attributed to the Bushmen, who are now extinct in Natal, and it is probable that some of them are of great antiquity, while others are comparatively speaking of quite recent origin. For instance, the case of the pictorial representation of a boat on one of these shelters, near Underberg (Pls. VIII. and IX.), cannot date further back than a few hundred years, the natives never having used boats, as the rivers are rarely navigable for any distance and lakes do not exist in most parts. It is more than probable that the artist had been to the coast and seen ships' boats. On the other hand, the representations of animals are not only interesting, but present a record of animals many of which are now entirely extinct in the locality in which the paintings occur. Mr. Giles, Magistrate at Impendhla, who spent a number of years at the Upper Tugela Magistracy, and who has an intimate knowledge of the Berg country in that district, informs me that he has recognised among the drawings in one of these shelters representations of a lion, tiger, puff-adder, &c. Although it is not so long since the last lion was killed in Natal, it is questionable whether in a cold climate like that of the Drakensberg on the Upper Tugela the lion ever existed. At the same time it is possible that at one time it may have visited this district during the summer. It is also possible that the artist may have seen the animal in some other part of the country and delineated it from memory. The range of the occurrence of these cave-shelters is very wide in the neighbourhood of the Drakensberg both laterally and vertically, and it would seem from this that the Bushmen, as the weaker race, were forced by the natives, who occupied the open country to the east, into the fastnesses of the mountain range, where they kept up a constant retaliation in the form of cattle-raiding on the stock of their more fortunate neighbours, until they were altogether exterminated.

Owing to the easily decomposed nature of the sandstones and shales, the greater number of these Bushmen paintings are very indistinct, and have undergone natural mutilation because of the scaling of the sandstone surface on which they were painted. Some of the finest examples are those which have decorated the roof of a shelter where the roof slab has fallen on the floor, and the drawings have been kept in a good state of preservation by being embedded

in the dry dust of the floor, which has prevented the air attacking the colouring material.

The more elevated parts of the Range consist of amygdaloidal basaltic lavas, which, however, in many localities have undergone complete denudation. The presence of these lavas has to a very large extent been the primary cause of the preservation of the plateau. They have at one time extended eastwards, over what is now Natal, much further than at present, but this portion has undergone denudation. Relics of them, in the form of waterworn fragments containing amygdules, which have been shed from the eroded portions of the lava sheets, are still to be found in the river gravels of the main river valleys, long distances to the east of the present slopes of the Drakensberg. These have, of course, been carried long distances from the Berg by the waters of the rivers. The lavas were erupted from a series of volcanic vents, which superficially formed cones. Surface evidences of some of these are still recognisable, particularly in the neighbourhood of Matatiele and other parts of the Transkeian Territory of Cape Colony. It is quite probable, however, that further north, nearer the Natal border, the remains of other volcanic pipes and orifices of eruption will be discovered, which were the immediate vehicles for the outflow of the lavas which have spread over what is now the top of the Drakensberg on our border. The period at which these outpourings of lavas occurred was probably during the initial stages of the elevation of the southern portion of the continent during late Jurassic times.

The valley of the Tugela River, for a considerable distance towards the Berg, consists of Upper Ecca shales, but before reaching the old Magistracy of Upper Tugela, above Bergville, and much sooner on the south side of the valley, the isolated mountains forming the foot-hills of the Berg, and usually capped by thick bedded sandstones, are composed of Beaufort Beds at their bases, while their summits are formed of outliers of Molteno Beds. These isolated mountains are present for over 20 miles from the actual base of the Berg-slope proper, and are much intersected by the subsidiary tributaries of the Tugela, which cut deeply into the Beaufort Series. The lower part of the actual Berg-slope consists of the Molteno Beds, which are overlaid, towards the top of the Range, by the Red Beds and Cave Sandstones, with occasional outliers of the amygdaloidal basaltic lavas.

The jagged sky-line contour is here produced from the irregular denudation, chiefly of the upper two sedimentary formations, the Cave Sandstones and the Red Beds, and the results have been the production of most varied forms, of the most interesting and fantastic character. The upper portion of the whole Range presents a scarred appearance on the face of these outcrops. These serrations are the results of the erosion caused by the stormwaters and those from the melting snows wearing vertical channels down the faces of the sandstone and shale exposures. Both "Champagne Castle" and the northern portion of "Mont-aux-Sources" are isolated from the main

face of the Range for a considerable distance below their summits These two detached outliers are, however, of considerable bulk. At some distance to the south of "Mont-aux-Sources" an outlier occurs which forms a series of columns of some thickness, irregularly joined together, along the joints at right angles to the cliff. These have been worn free from the main slope by the denudation of the joints which run parallel to the face of the Range. About half-way between "Mont-aux-Sources" and the "Cathedral" a somewhat similar series of columns occurs, but here the contour is much more rugged, owing to the joints at right angles to the Range having been denuded to a much greater depth, with the result that the sky-line contour presents a toothed or serrated appearance on a gigantic scale. Of the other masses which present contours above the ordinary sky-line, the forms are most varied, while the precipitous faces, which are not always perpendicular, are presented to all points of the compass. Although, from a distance, the Berg seems to have a single precipitous sloping face, it is not so, for between the farthest edge of the Berg from the spectator and the last kaffir habitations below there is an uninhabited zone, comprising innumerable inaccessible ridges of considerable elevation, with deep and rugged valleys, so that before the actual precipices are arrived at, a great deal of severe travel has to be undertaken. This applies to most parts of the Berg, but is not prevalent everywhere. For instance, the base of "Mont-aux-Sources" can be approached to within about 10 miles by cart and sledge, and the country intervening between the last camping-place and the foot of the cliffs which form its north-east and south-west faces, over which the waters of the Tugela River fall, is not of a particularly arduous character to the mountaineer.

A varying distance eastward from the Berg, about the horizon of the junction of the Ecca Series with the Beaufort Beds, enormous masses of intrusive basaltic rocks occur, but as the Range is approached nearer, the intrusive rocks are of much less frequent occurrence and are in less bulk, until on the Berg itself they are very rare. That is to say, that among the higher sedimentary strata of the Upper Karroo System the evidences of intrusion are much less frequent.

The part of the Drakensberg which seems to me to be the most impressive for boldness of outline and splendour of aspect is that north of "Champagne Castle," within the drainage area of the sources of the Tugela River. The Range, as far north as "Mont-aux-Sources," is over 8,000 feet in general elevation above the surrounding country, but to the north of the latter mountain it diminishes considerably in height, and becomes much broken up into isolated heights, such as "Mount Tintwa," "Rensberg's Kop," "Bloy's Mount," "Nelson's Kop," &c. A magnificent view of this portion of the Range can be obtained from any part of the Tugela River valley, as far as 40 miles away from the waterfall on "Mont-aux-Sources," by one day's drive from the railway at Ladysmith, Frere, Ennersdale, or Estcourt. Another day's

trek will take one to certain points within five or ten miles of the base of the scarp. A nearer approach can only be effected on foot, and along this area it is practically an unknown and inaccessible series of rugged mountains and deep impassable gorges. No known pass exists in this stretch of mountains between the Koodoo Pass immediately north of "Mont-aux-Sources" and south of "Champagne Castle," a fact which bears out the ruggedness and inaccessibility of this inhospitable region.

From "Giant's Castle" southwards, the actual Berg is much more easily approachable, because the country formed of the foot-hills is more open and less rugged, while the general level of the river systems approaches nearer to the level of the lower part of the Berg scarp. The result is that the ridges from the main Range are longer and have more gentle slopes, because of the less grade of the rivers, which have therefore not produced erosion to such great depths as further north in the Range. The main scarp is not nearly so scarred as the northern part, and isolated, precipitous rock-masses are of comparatively rare occurrence. Where they do occur they are not so precipitous, nor of such great bulk.

The three highest points of the Range and in South Africa are "Champagne Castle," "Giant's Castle," and "Mont-aux-Sources." Viewed from the Orange River Colony and Basutuland side they do not present a very imposing appearance, owing to the elevated plateau-like character of the country. From the Natal side, however, they present magnificent precipitous faces. The "Mont-aux-Sources" has no actual peak, but to the north of the point at which the waters of the Tugela waterfall flow over the edge of its cliffs, an isolated rock-mass stands out in bold relief against the sky, as immediately to the north of this mountain the height of the Range drops considerably. This outlier presents a roughly triangular form when viewed from the Upper Tugela valley, gradually tapering to the summit, which is flat and of small extent. From a distance of 20 miles its sides present clean precipitous faces, while the angular edge between them is irregularly sloping and appears to be sharp and razor-like. Although apparently so inaccessible from the Natal side, I have been told that a somewhat gradual slope connects this rock-mass with the main range, and that the ascent from the Orange River Colony is comparatively easy.

From various points on the main line of railway distant views of the higher Drakensberg can be obtained. The principal of these are:—From the neighbourhood of Ennersdale, an extensive view from "Mont-aux-Sources" to south of "Giant's Castle," the most imposing portion of the Berg; from between Beacon Hill and Willow Grange, that part of the Berg to the north and south of "Champagne Castle"; from between Highlands and Mooi River, a large portion to the north and south of "Giant's Castle," which can also be seen from between Howick and Cedara stations.

To the mountaineer this Range presents many declivities and rock-faces which are inaccessible to ordinary climbers. Numbers

of isolated pinnacles, buttes, precipices, &c., occur, but usually in out-of-the-way localities, which would try the best nerved and most experienced of mountain climbers. There is certainly nothing like a Jungfrau, or the inaccessible peaks of the Himalayas or the Andes, or even anything approaching a Mount Kenia or a Mount Kilimanjaro of Central Africa; but taking everything into consideration there is admirable scope here for local mountaineering, more so, for instance, than there is in Britain, or even in Australia. The base of the Range is so far off the beaten track that only parties with organised transport can undertake the climbing of the most dangerous parts. There are, however, many difficult heights within easily accessible distance of the main railway and farming districts, with fairly good roads, which could be conveniently reached for a day or two's climbing.

The rock-faces consist chiefly of shales and sandstones. The basaltic rocks which sometimes occur are often exposed as extensive rock-faces, through the denudation of the shales from their neighbourhood. The shales are exceedingly friable, and disintegrate, even on a more or less vertical face, into very small fragments which form a most treacherous foothold. The sandstones are also exceedingly friable and present more or less rounded contours on exposed disintegrated surfaces. They are well jointed, but the joints do not, as a rule, penetrate to great depths. The sandstones and shales usually form the most important pinnacles and rock-masses, and are therefore the rocks which are most likely to be negotiated in climbing. The basalts on their outcrops are generally much decomposed, and owing to the fact that the climate is so dry, the decomposed material on these outcrops does not get washed away, which would leave a clean hard rock-surface, as is the case in all temperate and sub-arctic climates.

From whatever point in Natal this range is viewed, it presents features apparently similar to most mountain ranges, but when a more intimate knowledge of its physical geology has been obtained, and it is realised that it is the irregularly broken, denuded edge of an extensive plateau, it has greater significance in relation to the physical geology of Natal and the neighbouring Colonies.

The northern and southern portions of the Berg not being of such great height nor of so rugged a character as the central portion, passes which will allow of transport by pack-animals are of frequent occurrence; but from the Koodoo Pass north of "Mont-aux-Sources" to the south of Bushman's Pass between "Champagne Castle" and "Giant's Castle," there is not one known by which pack-animals can pass from Natal over the Range into Basutuland. It is true, however, that in this area there may be points, known only to the natives, where they can make an arduous journey through the Berg on foot. In the days of the now extinct Bushmen, it is said to have been marvellous with what facility these small, wiry free-booters made their way up into the inaccessible recesses of these mountains, particularly when pursued by the Natal natives after a cattle-raid

into Natal. But where these nimble and fearless mountain pigmies could go with safety and impunity, the ordinary white man dare not follow, unless he is imbued with the courage and experience of a trained mountaineer.

The best time of year to view the beauties of this range and at the same time enjoy comfort in travelling, is in the winter season, during the months of May, June, July and August, the two latter of which frequently turn out disagreeably windy, and in August rains may be prevalent. At other times of the year the weather is usually insufferably hot, and the atmosphere is often hazy with the smoke of grass fires, or the Berg is enveloped in masses of clouds or mist. In the cold, clear, fresh air of a winter's morning the Range stands out in wonderful relief, with its remarkable changing shadows, all apparently so near that it is almost impossible for one to realise the greatness of the intervening distance. On such a morning, say, from the valley of the Upper Tugela, to watch, in the still, cold grey light of early dawn, the first warm tints of the rising sun touch the black mass of the higher Drakensberg—as, gradually, with the advancing light, the various members of the Range become differentiated, until, with the increasing sunshine, the whole scarp becomes bright, except for the intensely black shadows of varying form, which change so rapidly as the sun's rays become more vertical—is a picture which sinks into the mind, never to be eradicated, and which, in after-years, is often unconsciously drawn upon as a source of exquisitely pleasant recollection. It is certainly not so awe-inspiring in awful grandeur, or in the feeling of immensity, desolateness, and utter inaccessibility, as the tier upon tier of mountain ranges, culminating on the distant sky-line, a hundred miles away, either in the snow-white peak of Kanjingunga or Mount Everest in the Himalayas, as seen from the neighbourhood of Darjeeling at sunrise. If it remains calm, after a clear morning, when the sun has attained some height, there is commonly developed in the atmosphere a beautiful bluish haze, the origin of which is inexplicable, but the effect is marvellous and indefinable, softening as it does the outlines on the sky-line and the shadows, while leaving the atmosphere brilliantly clear, and forming a mellowing medium through which the harshness of highly contrasting outlines and colours is subdued in a wonderful and pleasing way. This is purely an attribute of that portion of the Range between "Mont-" "aux-Sources" and "Champagne Castle" as seen from Upper Tugela. To a much less degree it sometimes occurs further south along the Range.

CRETACEOUS FOSSILS OF NATAL.

Part III.

I.—THE CEPHALOPODA FROM THE DEPOSIT AT THE NORTH END OF FALSE BAY, ZULULAND.

II.—THE CEPHALOPODA FROM THE TRIBUTARIES OF THE MANUAN CREEK, ZULULAND.

III.—NOTE ON A CRETACEOUS AMMONITE FROM THE MOUTH OF THE UMPENYATI RIVER, NATAL.

By G. C. CRICK, A.R.S.M., F.G.S.,

Of the British Museum (Natural History), London.

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CRETACEOUS FOSSILS OF NATAL,

COLLECTED BY

MR. WILLIAM ANDERSON, Government Geologist.

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I.—THE CEPHALOPODA FROM THE DEPOSIT AT THE NORTH END OF FALSE BAY, ZULULAND.

I.—INTRODUCTION.

The fossils described in the following pages have been submitted to me for examination and description. They were collected by Mr. William Anderson, Government Geologist, at the "North End of" "False Bay, Zululand." In his "First Report of the Geological" "Survey of Natal and Zululand" (1901), Mr. Anderson states (p. 47) that he had been able to visit three localities in Zululand where outcrops of the Cretaceous rocks occur. He describes them as follows: "One of these is on the south bank of the Umfolosi"

" River, close to Lake Isitesa, and about 20 miles above its mouth." " Another is on the Umsinene River, some miles to the west of " " the north end of False Bay, a portion of St. Lucia Lake. The " " third is in the bed of the creek, about a couple of miles to the " " east of Crossly's Store, Bombeni, near the southern end of the " " Lebombo Range."

The fossils from the first locality, or the Umkwelane Hill Deposit, were described by Mr. Etheridge in the " Second Report " " of the Geological Survey of Natal and Zululand," 1904, pp. 69–93; the fossils from the second, the Umsinene River Deposit, are described, also by Mr. Etheridge, in the present Report; whilst the description of the Cephalopod fauna from the third locality, the Manuan Creek Deposit, forms a subsequent portion of the present Report.

In the " Second Report of the Geological Survey of Natal and " " Zululand," 1904, Mr. Anderson says (p. 48): " Quite a number of " " new localities have been met with in which the Cretaceous rocks are " " fossiliferous. Among these may be mentioned the north-western " " edge of False Bay and the inner portion of St. Lucia Lake. The " " first-mentioned outcrop occurs on the game path on the water-level " " of the western side of the lake, about two miles south of the north " " end of False Bay. The beds are gritty, felspathic sandstones, more " " or less calcareous, with clays and marls. In these occur numerous " " fossils, chiefly *Gasteropoda* and corals. As there was little time " " on the occasion of my visit to do any extensive work in the " " way of collecting, I had to be content with much decomposed " " specimens."

This appears to be the locality at which the fossils described in the following pages were obtained. As will be seen from Mr. Anderson's " Geological Sketch Map of Zululand," published in the Second Report (Pl. XI.), it is not far from, only a little to the east of, the Umsinene River Deposit, the fossil fauna of which is described by Mr. Etheridge in the present Report.

The collection consists principally of Ammonites; it contains a few Nautili, but no Belemnites.

At the end of the descriptions of the species are appended notes on three specimens which were included with the collection. One of these subsequently proved to be from the Umkwelane Hill Deposit, the contents of which have already been described by Mr. Etheridge in the Second Report; the other two specimens, both fragments, seem not only from their matrix, but also from their affinities, to have come from a locality different from the rest of the collection.

Of such importance is the collection that it is to be regretted that it has not been possible to figure the whole of the species represented, especially the larger examples, many of which are, however, very fragmentary; but to have done so, even on a reduced scale, would have far exceeded the number of the plates allowed to illustrate this

portion of the Report. I would express my thanks to the artist, Mr. A. H. Searle, for the care which he has taken in the preparation of the excellent drawings illustrating the present paper.

II.—DESCRIPTION OF THE SPECIES.

A. AMMONOIDEA.

The scheme adopted in the following descriptions is that given in the introduction to the "Catalogue of the Fossil Cephalopoda in the" "British Museum (Natural History)," Pt. iii., 1897, p. xviii, except that the term "umbilical zone" is substituted for the expression "inner area of the whorl."

Unfortunately, in most cases the suture-lines are not preserved, or if present the surface of the fossil has been so much altered either by weathering or by mineralisation, or by both combined, that it is almost impossible to follow them. In many cases, however, the body-chamber is missing, the anterior end of the specimen being formed by a septal surface.*

The Ammonoidea dealt with in the succeeding pages include the following genera :—

1. *Phylloceras*, Suess.
2. *Gaudryceras*, Grossouvre emend. Kossmat.
3. *Tetragonites*, Kossmat.
4. *Turrilites*, Lamarck.
5. *Baculites*, Lamarck.
6. *Knemoceras*, Böhm.†
7. *Forbesiceras*, Kossmat.
8. *Acanthoceras*, Neumayr.
   - (*a*) Group of *Acanthoceras rotomagense*, Defr., sp. (*Metacanthoplites*, *Calycoceras*, Hyatt).
   - (*b*) Group of *Acanthoceras colerunense*, Stoliczka.
9. *Desmoceras*, Zittel emend. Grossouvre.
10. *Puzosia*, Bayle.

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* The nomenclature adopted for the suture-lines is as follows: The *ventral* (or *external*) *lobe* is bounded on each side of the mesal plane of the shell by the *external* (or *outer*) *saddle*; this is followed by the *first lateral lobe*; then follows the *first lateral saddle*, succeeded in turn by the *second lateral lobe* and the *second lateral saddle*. The lobes and saddles occurring between the second lateral saddle and the "line of" "involution" (or suture of the shell) are termed *auxiliaries*, and are numbered in regular order. The *dorsal* lobe is also known as the *internal*, *antisiphonal*, or *columellar* lobe.

† Respecting the spelling of the name of this genus see P. G. Krause, Samml. geol. Reichsmus. Leiden, Ser. I., Bd. vii., Heft. i., 1902, pp. 7, 8.

1. Genus Phylloceras, *Suess.*

(Ueber Ammoniten: Sitzungsberichte d. nat.-wiss. Classe d. k. Akad. d. Wissensch., Wien, Bd. lii., Abth. i., 1865 (1866), p. 76.)

Phylloceras Velledæ (*? Michelin, sp.*),* *Stoliczka, sp.*

(Pl. X., Figs. 10, 10*a*; 11, 11*a*.)

1865. *Ammonites Velledæ*, F. Stoliczka,† Cret. Fauna S. India (Pal. Indica), i., Cephalopoda, p. 116, Pl. lix., f. 1–4.

Observations.—Of the three examples representing the *Phylloceratidæ*, two seem to be referable to the same species.

The larger specimen (Pl. X., Figs. 11, 11*a*) consists of a portion of the natural cast of part of the septate portion of a shell showing at its anterior end the form of the greater part of a septal surface, the portion near the periphery being wanting. The length of the specimen, measured along the periphery and allowing for the small piece which has been broken off the ventral portion of the anterior end, is about 65 mm.; the ventro-dorsal (making a similar allowance for the break) and the transverse diameters of this end are (about) 26 and 19 mm. respectively, the greatest thickness being at a short distance from the border of the small umbilicus. At the opposite end the thickness at the middle of the lateral area is only 15 mm. The sides are somewhat flattened and the periphery broadly rounded. The test is not preserved, but its sculpture on the peripheral area is clearly indicated; this consists of fine regular raised striæ which pass straight across the periphery and are directed slightly forward as they pass on to the lateral area.

The smaller specimen (Pl. X., Figs. 10, 10*a*) is exceedingly well preserved and entirely septate; it has the following dimensions: Diameter, 29 mm. (1); height of last whorl, 17 mm. (0·58); thickness of last whorl, 10·5 mm. (0·36); and width of umbilicus, 2 mm. (0·07). The sides are flattened, and the periphery rather broadly rounded, the greatest thickness of the whorl being at about the middle of the lateral area. Over the greater part of the specimen, the test, which appears

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* H. Michelin, Magasin de Zoologie, 1834, Pl. xxxv.

† This volume by F. Stoliczka (except pp. 1–40, by H. F. Blanford) was issued, as stated in the note at the end of the explanatory notice of the volume, in parts as follows:—

Pages	1–40	Plates	i.–xxv.	Issued	November, 1861.
,,	41–56	,,	xxvi.–xxxi.	,,	October 1, 1863.
,,	57–70	,,	xxxii.–xxxvii.	,,	January 1, 1864.
,,	71–82	,,	xxxviii.–xliii.	,,	April 1, 1864.
,,	83–94	,,	xliv.–xlix.	,,	July 1, 1864.
,,	95–106	,,	l.–liv.	,,	October 1, 1864.
,,	107–122	,,	lv.–lix.	,,	January 1, 1865.
,,	123–130	,,	lxi.–lxv.	,,	April 1, 1865.
,,	131–142	,,	lxvi.–lxx.	,,	July 1, 1865.
,,	143–154	,,	lxxi.–lxxx.	,,	October 1, 1865.
,,	155–216	,,	lxxxi.–xciv.	,,	January, 1866.

(With Appendix, Index, Title, &c.)

The date of issue of Pl. lx. is not given.

to have been very thin, is preserved only on the peripheral area; here the ornaments consist of regular fine raised striæ which are almost straight on the periphery and only slightly forwardly-directed as they pass on to the lateral area; on the youngest part of the outer whorl, however, a small portion of the test is present on the side, showing that at about the middle of the lateral area the raised striæ become much finer and curve backward in passing over the inner half of the lateral area to the edge of the umbilicus. The suture-lines are preserved, but are extremely difficult to follow; besides the ventral lobe there are on each side nine saddles and eight lobes, decreasing regularly in size between the periphery and the suture of the shell.

Mr. Anderson's specimens are closely allied to, if not specifically identical with, the examples figured by Stoliczka * as *Phylloceras Velledæ* (Michelin) † from the Utatúr Group of Southern India, the larger specimen closely resembling, and forming part of the body-chamber of a fossil nearly as large as the largest example figured by Stoliczka (Pl. lix., f. 2, 2*a*), whilst the smaller specimen is comparable with, although neither quite so large nor so inflated as, the "inflated variety" represented by the same author (Pl. lix., f. 4, 4*a*). They evidently belong to the group of forms for which Grossouvre ‡ has proposed the generic name *Schlueteria*, a genus which he shortly diagnosed as including "espèces de la craie" "supérieure, analogues aux *Phylloceras* par leur forme et leur orna-" "mentation, mais dont la ligne suturale se rapproche vraisemblable-" "ment de celle des *Puzosia* et des *Pachydiscus* et diffère, en tout cas," "de celle des *Phylloceras* par l'absence des larges feuilles qui terminent" "les ramifications des cloisons." The last true *Phylloceras* that author considered to be in the Gault, viz., *Phylloceras Velledæ*, Michelin, sp., § and *Phylloceras subalpinum*, d'Orbigny, sp.|| Kossmat,¶ however, does not recognise the validity of this genus, and of the species ascribed to it by its author he refers three (*Schl. Pergensi*, Grossouvre; ** *Schl. Rousseli*, Grossouvre; †† and *Schl. Velledæformis*, Schlüter, sp.),‡‡ which he considers to be most nearly related to *Phylloceras Velledæ*, Michelin, sp., to the genus *Phylloceras*, whilst the fourth (*Schl. Larteti*, Seunes, sp.) §§ he retains in the genus *Desmoceras*, the genus to which it was originally referred by its

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* F. Stoliczka, Cret. Fauna S. India (Pal. Indica), i., Cephalopoda, p. 116 (1865), Pl. lix., f. 1–4.

† H. Michelin, Magasin de Zoologie, 1834, Pl. xxxv.

‡ A. de Grossouvre, Recherches sur la craie supérieure, Pt. 2, Paléontologie, Les Ammonites de la craie supérieure, 1893, p. 216.

§ H. Michelin, *loc. cit.*

|| A. d'Orbigny, Pal. Franç. Terr. crét., 1840, i., p. 283, Pl. lxxxiii., f. 1–3 (*Ammonites alpinus*); and Prod. de Paléont., 1850, ii., p. 124 (*Ammonites subalpinus*).

¶ F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 1 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, Bd. ix., Heft iii. and iv.), 1895, p. 9 (105).

** A. de Grossouvre, Recherches sur la craie supérieure, Pt. 2, Paléontologie, Les Ammonites de la craie supérieure, 1893, p. 217.

†† *Ibid.*, p. 217, Pl. xxiv., f. 2.

‡‡ *Ibid.*, p. 218.

§§ *Ibid.*, p. 218, Pl. xxxiv., f. 2, 3.

author.* According, therefore, to Dr. Kossmat, the African specimens are referable to the genus *Phylloceras*. But whether the Indian examples figured by Stoliczka † and by Kossmat ‡ are correctly referred to Michelin's species *Velledæ* appears to us to be open to doubt. Kossmat § says the Indian forms are identical with the European in external form, sculpture, and lobe-line, but on referring to Michelin's figure we notice that this represents a form with a closed umbilicus, whilst the Indian examples, like the African ones, have a narrow, deep umbilicus. Moreover, Michelin's specimen came from the Gault (Albian) of France, whereas the Indian species, stated by Stoliczka || to be common in the Utatúr Group, is restricted by Kossmat ¶ to the lower part of that group, that is, to the part which he regards as Lower Cenomanian.** Since we regard the African specimens as most probably specifically identical with the examples figured by Stoliczka as *Phylloceras Velledæ* from the Utatúr Group of India, and, following Dr. Kossmat, retain them in the genus *Phylloceras*, we accept Stoliczka's name for them, but the material at our disposal is not sufficient to enable us to express an opinion as to their identity with Michelin's species.

Two examples of this genus have been recorded from the rocks to the south, and near the mouth, of the Conducia River, which debouches into the Indian Ocean a little north of the island on which the town of Mozambique stands. One of these specimens, collected by Peters in 1843, was regarded by Beyrich as being probably of Neocomian age, an opinion in which he was supported by Neumayr,†† who figured the specimen and referred it to *Phylloceras semistriatum* (d'Orbigny),‡‡ a species occurring in the Neocomian of France. The other example from the same locality is a mere fragment, and together with Peters' specimen is recorded as *Phylloceras* cfr. *semistriatum* (d'Orbigny) by Choffat,§§ who reproduces Neumayr's figures and at the same time points out the similarity existing between the specimen collected by Peters and the figures given by Stoliczka¶¶ and by

* J. Seunes, Contributions à l'étude des Céphalopodes du Crétacé supérieur de France, sér. ii., i., Ammonites du calcaire à Baculites du Cotentin, p. 19, Pl. iii., f. 2, Pl. iv., f. 2, 3. (Mém. Soc. géol. France, ii.)

† F. Stoliczka, Cret. Fauna S. India (Pal. Indica), i., Cephalopoda, p. 116 (1865), Pl. lix., f. 1–4.

‡ F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 1 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. ix., Heft iii. and iv.), 1895, p. 12 (108), Pl. i. (xv.), f. 3 (suture-line).

§ *Ibid.*, p. 12 (108).

|| F. Stoliczka, *op. cit.*, p. 117.

¶ F. Kossmat, *op. cit.*, p. 108.

** F. Kossmat, Jahrb. d. k.k. geolog. Reichsanst., Wien, Bd. xliv., 1894, Heft iii. and iv. (1895), p. 460.

†† M. Neumayr, Denkschr. d. k. Akad. d. Wissensch., Math.-naturw. Cl., Wien, Bd. l., 1885, pp. 110, 139, Pl. i., f. 2*a*, 2*b*.

‡‡ A. d'Orbigny, Pal. Franç., Terr. crét., i., p. 136, Pl. xli., f. 3, 4; and (under the name *Amm. Thetys*), p. 174, Pl. liii., f. 7–9. Subsequently d'Orbigny (Prod. de Paléont., ii., p. 64) adopts the latter name (but spells it *Tethys*) for this species.

§§ P. Choffat, Contributions à la connaissance géologique des colonies portugaises d'Afrique, i., Le Crétacique de Conducia, 1903, p. 17, Pl. i., f. 10*a*, *b*. (Comm. Serv. géol. Portugal.)

¶¶ F. Stoliczka, Cret. Fauna S. India (Pal. Indica), i., Cephalopoda, p. 116 (1865), Pl. lix., f. 1–4.

Kossmat * of examples from the Lower Utatúr Group of India that they refer to *Phylloceras Velledæ* (Michelin).† Neumayr gave no sectional view of Peters' specimen, but it is possible that the Conducia specimens are specifically identical with the Indian specimens referred to *Phylloceras Velledæ*, and therefore with the present examples.

The genus has also been recorded from the Cretaceous rocks of Pondoland.‡

It is most probably the present species, which, under the name *Phylloceras Velledæ*, has been recorded by M. Boule § and others from the north and north-west of Madagascar; by Yokoyama || from Yesso (Japan); by Schmidt ¶ from Sachalin; and possibly as *Ammonites ramosus* by Gabb** from California. Whiteaves†† recorded *Ammonites Velledæ* from Vancouver Island, but subsequently ‡‡ referred his specimens to *Phylloceras ramosum*, Meek, sp., because the Vancouver species was apparently not the *Ammonites Velledæ* of European authors. *Ammonites Velledæ* has been identified §§ from the Rotomagian of North Africa, and quite recently Kilian |||| has recorded, among the specimens obtained from the north-east coast of Graham Land by the Swedish Antarctic Expedition, the occurrence of *Phylloceras* cf. *Velledæ* and *Phylloceras ramosum*, Meek.

Phylloceras cf. ellipticum, *Kossmat.*

(Pl. X., Figs. 12, 12*a*.)

1895. *Phylloceras ellipticum*, F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 1 (Beitr. zur. Paläont. u. Geol. Österr.-Ungarns, &c., Bd. ix., Heft iii. and iv.), p. 11 (107), Pl. i. (xv.), f. 2*a*, *b*; Pl. vi. (xx.), f. 1*a*, *b*.

Observations.—Another species of *Phylloceras* is represented by half an individual measuring along the fractured edges 55 mm.

* F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 1 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. ix., Heft iii. and iv.), 1895, p. 12 (108), Pl. i. (xv.), f. 3 (suture-line).

† H. Michelin, Magasin de Zoologie, 1834, Pl. xxxv.

‡ H. Woods, Ann. S. African Museum, iv., Pt. 7, 1906, pp. 331–2.

§ M. Boule, in Madagascar au début du xx^e^ siècle, by R. Blanchard and others, 1902, p. 53. A. Thevenin, Bull. Soc. géol. France [4], v., 1905, p. 483. P. Lemoine, Études géologiques dans le nord de Madagascar, 1906, pp. 205, 221. M. Boule, P. Lemoine, and A. Thevenin, Ann. de Paléont., i., fasc. iv., 1906, pp. 179(7)–181(9), Pl. i., f. 6, 6*a*, 6*b*, 6*c*, 10, 11.

|| M. Yokoyama, Palaeontographica, Bd. xxxvi., Lief. 4–6, 1890, p. 177, Pl. xix., f. 1*a*, *b*.

¶ F. Schmidt, Mém. Acad. Imp. Sci. St. Pétersbourg, sér. vii., xix, No. 3, 1873, p. 10, Pl. i., f. 3, 4.

** W. M. Gabb, Geol. Surv. California, Palæontology, i., 1864, p. 65, Pl. xi., f. 12, 12*a*; Pl. xii., f. 12*b*.

†† J. F. Whiteaves, Mesozoic Fossils, i., Pt. ii., 1879, p. 103.

‡‡ *Ibid.*, i., Pt. v., 1903, p. 327.

§§ H. Coquand, Géologie et paléontologie de la region sud de la province de Constantine, 1862, p. 288.

|||| W. Kilian, Comptes Rendus, cxlii., No. 5 (January 29, 1906), p. 306. See also preliminary list of Cretaceous Cephalopoda given by W. Kilian, in J. Gunnar Andersson, On the Geology of Graham Land, Bull. Geol. Inst. Upsala, vii., 1904–5, [1906], pp. 35, 36.

The fragment is entirely septate, and at its greatest diameter—55 mm. (1)—has the following dimensions: Height of outer whorl, 31 mm. (0·56); greatest thickness, 19 mm. (0·34); and width of umbilicus (test absent), 5 mm. (0·09). The cross-section of the whorl is elliptical, the greatest thickness being at about the centre of the lateral area. The test, judging from fragments that still adhere to the specimen, seems at first sight to have been entirely smooth; near the anterior end of the specimen, however, the periphery is crossed by straight, slightly backwardly-directed, distant striæ, which become much feebler on the sides and curve forward at about the middle of the lateral area. There appear to be slight indications of constrictions on the internal cast, but these are exceedingly obscure and doubtful. The greater part of the specimen is denuded of the test, but the surface is so eroded that the complicated sutures, although present, cannot be traced. From the preceding species it can be readily distinguished by its more inflated sides and the consequent more elliptical transverse section of the whorls.

It appears to be nearly allied to *Phylloceras ellipticum*, Kossmat,* from the Lower Utatúr Group of Southern India, but that shell is more inflated and has a more broadly-rounded periphery than the present specimen.

2. Genus Gaudryceras, *Grossouvre emend. Kossmat.*†

(A. de Grossouvre, Recherches sur la craie supérieure, Pt. 2, Paléontologie, Les Ammonites de la craie supérieure, 1893, p. 225; and F. Kossmat, Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. ix., Heft iii. and iv., 1895, p. 113.)

Group of Gaudryceras Sacya, *Forbes, sp.*

(Kossmat, Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. ix., Heft iii. and iv., 1895, p. 115.)

Gaudryceras aff. Sacya, *Forbes, sp.*

(Pl. X., Figs. 13, 13*a*.)

1846. *Ammonites Sacya*, E. Forbes, Trans. Geol. Soc. London, ser. 2, vii., Pt. 3, p. 113, Pl. xiv., f. 10.‡

Observations.—The interesting group of *Gaudryceras Sacya*, Forbes, sp., is represented by a portion of the septate part of a shell, consisting of a portion of three whorls. Each of the inner whorls consists

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* F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. i. (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. ix., Heft iii. and iv.), 1895, p. 11 (107), Pl. i. (xv.), f. 2*a*, *b*; Pl. vi. (xx.), f. 1*a*, *b*.

† See also H. Yabe, Journ. Coll. Sci., Imp. Univ., Tōkyō, xviii., Art. 2, 1903, p. 13.

‡ For synonymy and references see F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 1 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. ix., Heft iii. and iv.), 1895, p. 23 (119).

of about half a turn, but the outer whorl does not form quite half a turn. If the whorls had been complete the dimensions of the specimen at its greatest diameter would have been: Diameter, 38 mm. (1); height of outer whorl, 16 mm. (0·42); thickness of outer whorl, 16 mm. (0·42); width of umbilicus, about 14 mm. (0·36). Only a few fragments of the test are preserved; these on the peripheral area show that the surface there was ornamented with fine transverse thread-like striæ. Of the species which Dr. Kossmat * refers to this group, the African example comes nearest *Gaudryceras Sacya*, Forbes, sp., a species which, according to Stoliczka,† "in the form and number of the whorls" "in several stages of growth . . . exhibits a good many variations." Although it increases rather more rapidly than Forbes's original specimen, it is evidently closely allied to, if not identical with, that species.

The species *Gaudryceras Sacya* occurs in the Lower Utatúr Group of Southern India, and has also been recorded from Conducia in Portuguese East Africa north of Mozambique,‡ from Yesso,§ Sachalin,|| Queen Charlotte Islands,¶ and California.** Among the specimens brought back by the Swedish Antarctic Expedition Kilian†† has recently recorded the occurrence of a *Gaudryceras* belonging to the group of *Gaudryceras Sacya;* whilst from the north of Madagascar MM. Boule, Lemoine, and Thevenin ‡‡ have described and figured a specimen as *Lytoceras* (*Gaudryceras*) cf. *Sacya*, Forbes.

Gaudryceras odiense, *Kossmat.*

(Pl. X., Figs. 14, 14*a*.)

1895. *Lytoceras* (*Gaudryceras*) *Odiense*, F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 1 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. ix., Heft iii. and iv.), 1895, p. 33 (129), Pl. iv. (xviii.) f. 1*a*–*c*; Pl. v. (xix.), f. 3.

Observations.—This species appears to be represented by a

* F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 1 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. ix., Heft iii. and iv.), 1895, pp. 19 (115)–22 (118).

† F. Stoliczka, Cret. Fauna S. India (Pal. Indica), i., Cephalopoda, p. 155.

‡ P. Choffat, Contributions à la connaissance géologique des colonies portugaises d'Afrique, i., Le Crétacique de Conducia, 1903, p. 14, Pl. i., f. 2*a*, *b*; 3. (Comm. Serv. géol. Portugal.)

§ M. Yokoyama, Palaeontographica, Bd. xxxvi., Lief. 4–6, 1890, p. 178, Pl. xviii., f. 12, 13. K. Jimbo, Pal. Abhandl., Dames and Kayser, Bd. vi., Heft 3, 1894, p. 34 (180), Pl. vi. (xxii.), f. 1. H. Yabe, Journ. Coll. Sci., Imp. Univ., Tōkyō, xviii., Art. 2, 1903, p. 19 (*G. tenuiliratum*).

|| F. Schmidt, Mém. Acad. Imp. Sci. St. Pétersbourg, sér. vii., xix., No. 3, 1873, p. 15, Pl. ii., f. 3, 4.

¶ J. F. Whiteaves, Mesozoic Fossils, i., Pt. iii., 1884, p. 203, Pl. xxv.; and Mesozoic Fossils, i., Pt. i., 1876, p. 43, Pl. ii., f. 2, 3—*Ammonites* (*Lytoceras*) *filicinctus*.

** J. S. Diller and T. W. Stanton, Bull. Geol. Soc. America, v., 1894, p. 445.

†† W. Kilian, Comptes Rendus, cxlii., No. 5 (January 29, 1906), p. 306. See also preliminary list of Cretaceous Cephalopoda given by W. Kilian, in J. Gunnar Andersson, On the Geology of Graham Land, Bull. Geol. Inst. Upsala, vii., 1904–5, [1906], pp. 35, 36.

‡‡ Ann. de Paléont., i., fasc. iv., 1906, p. 184 (12), Pl. ii., f. 2, 2*a*, 2*b*.

completely septate specimen having the following dimensions: Diameter of shell, 23 mm. (1); height of outer whorl, 12 mm. (0·52); thickness of outer whorl, 7 mm. (0·30); and width of umbilicus, 4 mm. (0·17). Portions of the test are present but are so very much weathered that they have a laminated appearance, and do not exhibit the true character of the surface. The shell has its greatest thickness near the middle of the side and not close to the edge of the umbilicus, as is the case in *Gaudryceras Varuna*, Forbes,* sp. *Gaudryceras odiense* occurs in the Lower Utatúr Group in Southern India.

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3. Genus Tetragonites, *Kossmat.*

(Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. ix., Heft iii. and iv., 1895, pp. 112 and 131.)

Tetragonites Timotheanus (? *Mayor, sp.*),† *Stoliczka, sp.*

(Pl. X., Figs. 15, 15*a*; Pl. XIII., Figs. 5, 5*a*.)

1865. *Ammonites Timotheanus*, F. Stoliczka, Cret. Fauna S. India (Pal. Indica), i., Cephalopoda, p. 146, Pl. lxxiii., f, 3, 4, 6.‡

Observations.—To the species recognised from Southern India under this name by Stoliczka § and by Kossmat ‖ I refer a well-preserved and entirely septate specimen (Pl. X., Figs. 15, 15*a*) having the following dimensions: Diameter, 25 mm. (1); height of outer whorl, 10·5 mm. (0·42); thickness of outer whorl, 13·5 mm. (0·54); width of umbilicus, 7·5 mm. (0·30). As pointed out in the Indian examples by Kossmat, the suture-line of this specimen has several auxiliary lobes and saddles. Besides the characteristic constrictions, which are well shown, the surface of the test, of which a few well-preserved fragments are present, is nearly smooth, being traversed only by exceedingly fine lines of growth.

To this species probably also belongs an entirely septate specimen (Pl. XIII., Figs. 5, 5*a*) of which the surface is so much eroded that if any periodical constrictions were originally present they are not now visible. It has the following dimensions: Diameter, 81 mm. (1); height of outer whorl, 36 mm. (0·44); thickness of outer whorl,

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* E. Forbes, Trans. Geol. Soc. London, ser. 2, vii., Pt. 3, 1846, p. 107, Pl. viii., f. 5*a–c*.

† Mayor in F. J. Pictet and W. Roux, Moll. foss. grès verts, Genève, p. 39, Pl. ii., f. 6*a*, *b*; Pl. iii., f. 1*a*, *b*, *c*, and f. 2*a*, *b*.

‡ For references see F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 1 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. ix., Heft iii. and iv.), 1895, p. 37 (133).

§ F. Stoliczka, Cret. Fauna S. India (Pal. Indica), i., Cephalopoda, p. 146 (1865), Pl. lxxiii., f. 3, 4, 6 (not 5).

‖ F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 1 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. ix., Heft iii. and iv.), 1895, p. 37 (133), Pl. iii. (xvii.), f. 11, 13*a*, *b*.

40 mm. (0·49); width of umbilicus, 21 mm. (0·25). Owing to the eroded state of the specimen the details of the suture-lines are not preserved.

According to Dr. Kossmat's observations,* *Tetragonites Timotheanus* is one of the most plentiful species of the Utatúr Group in Southern India. To the same species Stoliczka † referred specimens from the Trichinopoli Group of Southern India, but these have been characterized by Dr. Kossmat as a distinct species—*Tetragonites epigonus.*‡

The species *Tetragonites Timotheanus* was first described by Pictet § from the Grès Verts at Saxonet, in Savoy, and has since been recorded from the Albian at several localities in the South of France ; whilst specimens have been referred to the same species from the north of Madagascar,‖ from Sachalin ¶ and the Queen Charlotte Islands**; and an allied form—*Tetragonites glaber*—has been described from Yesso.††

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4. Genus Turrilites, *Lamarck.*

(Syst. anim. sans vertèbres, 1801, p. 102.)

Turrilites Scheuchzerianus, *Bosc.*

(Pl. XI., Figs. 1, 1*a*.)

1802. *Turrilites Scheuchzeriana*, Bosc, Suite à Castel's ed. of Buffon's Hist. Nat., Coquilles, v., An x. (1802), p. 190.

1814. *Turrilites undulata*, J. Sowerby, Min. Conch., i., p. 171, Pl. lxxv., f. 1–3.

1822. *Turrilites undulatus*, G. A. Mantell, Fossils of the South Downs, p. 124, Pl. xxiii., f. 14, 16; Pl. xxiv., f. 8.

1840. *Turrilites Desnoyersi*, A. d'Orbigny, Pal. Franç., Terr. crét., i., p. 601, Pl. cxlvi., f. 1, 2.

1840. *Turrilites Scheuchzerianus*, A. d'Orbigny, *ibid.*, p. 602, Pl. cxlvi., f. 3, 4.

1856. *Turrilites Scheuchzerianus*, D. Sharpe, Foss. Moll. of the Chalk (Mon. Pal. Soc.), Pt. 3, p. 64, Pl. xxvi., f. 1–3.

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* F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 1 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. ix., Heft iii. and iv.), 1895, p. 38 (134).

† F. Stoliczka, Cret. Fauna S. India (Pal. Indica), i., Cephalopoda, p. 147.

‡ F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 1 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. ix., Heft iii. and iv.), 1895, p. 39 (135), Pl. iii. (xvii.), f. 4*a*, *b*, *c*; f. 5*a*, *b*.

§ F. J. Pictet, in F. J. Pictet and W. Roux, Moll. foss. grès verts, Genève, p. 39.

‖ E. Haug, Bull. Soc. géol. France, [3], xxvii., No. 4, 1899, p. 396. M. Boule, P. Lemoine, A. Thevenin, Ann. de Paléont., i., fasc. iv., 1906, p. 186 (14), Pl. ii., f. 3, 3*a*, 3*b*.

¶ F. Schmidt, Mém. Acad. Imp. Sci., St. Pétersbourg, sér. vii., xix., No. 3, 1873, p. 14, Pl. ii., f. 7–11.

** J. F. Whiteaves, Mesozoic Fossils, i., Pt. i., 1876, p. 41, Pl. iii., f. 2.

†† K. Jimbo, Pal. Abhandl., Dames and Kayser, Bd. vi., Heft 3, 1894, p. 34 (180), Pl. vi. (xxii.), f. 2 (*Lytoceras glabrum*). H. Yabe, Journ. Coll. Sci., Imp. Univ., Tōkyō, xviii., Art. 2, 1903, Pl. vii., f. 2, 5.

1861–62. *Turrilites Scheuchzerianus*, F. J. Pictet, Foss. terr. crét. Sainte-Croix, Pt. 2 (Pal. Suisse, sér. 3), livr. 2–3, 1861, p. 144; livr. 4, 1862, Pl. lviii., f. 6.

1862. *Turrilites Scheuchzerianus*, H. Coquand, Géologie et paléontologie de la region sud de la province de Constantine, p. 288.

1876. *Turrilites Scheuchzerianus*, C. Schlüter, Ceph. d. ober. deutsch. Kreide, Abth. ii., Lief. 1 (Palaeontogr., Bd. xxiv., Lief. 1, May, 1876), p. 123 (3), Pl. xxxvi. (i.), f. 11–15.

1882. *Turrilites Scheuchzerianus*, G. Seguenza, Atti R. Accad. dei Lincei, ser. 3, xii., p. 116.

1903. *Turrilites Scheuchzerianus* and *T. Desnoyersi*, L. Pervinquière, Étude géol. de la Tunisie centrale (Carte géol. de la Tunisie), p. 93.

Observations.—In Mr. Anderson's collection three specimens exhibiting different stages of growth seem to be referable to this species. The smallest specimen, exhibiting the young stages of growth, is 79 mm. long, and consists of five whorls, the diameters of the first and last whorls being 13 and 30 mm. respectively; the example (Pl. XI., Figs. 1, 1*a*) exhibiting the intermediate stages of growth is 93 mm. long, and consists of four and a half whorls, the diameters of the first and last whorls being 21 and 42 mm. respectively; whilst the characters of the adult are shown in a specimen which is about 118 mm. long, with a little more than three whorls, the diameter of the first whorl being 38 mm., and that of the last, if it had been complete, about 57 mm. The smallest specimen and the medium-sized example exhibit the interruption of the ribbing characteristic of the young and adolescent stages of *Turrilites Scheuchzerianus*.

This characteristic species occurs in the Cenomanian of Germany,* France,† Switzerland,‡ Italy,§ England,‖ and North Africa;¶ but hitherto, so far as I am aware, has not been recorded from the Cretaceous rocks of India.

Turrilites costatus, *Lamarck*.

(Pl. XI., Fig. 2.)

1801. *Turrilites costata*, Lamarck, Syst. des. Anim. sans vertèbres, p. 102.

1813. *Turrilites costatus*, J. Sowerby, Min. Conch., i.. p. 81, Pl. xxxvi.

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* See C. Schlüter, Ceph. d. ober. deutsch. Kreide, Abth. ii., Lief. 1 (Palaeontographica, Bd. xxiv., Lief. 1, May, 1876), p. 125 (5).

† A. d'Orbigny, Pal. Franç., Terr. crét., i., 1840, p. 602, Pl. cxlvi., f. 3, 4; and *ibid.*, p. 601, Pl. cxlvi., f. 1, 2 (*Turrilites Desnoyersi* = *Turrilites Scheuchzerianus*).

‡ F. J. Pictet, Foss. terr. crét. Sainte-Croix, Pt. 2 (Pal. Suisse, sér. 3), 1861–64, p. 144, Pl. lviii., f. 6.

§ G. Seguenza, Atti della R. Accad. dei Lincei, ser. 3, 1882, xii., p. 116.

‖ D. Sharpe, Foss. Moll. of the Chalk (Mon. Pal. Soc.), Pt. 3, 1856, p. 64, Pl. xxvi., f. 1–3.

¶ H. Coquand, Géologie et paléontologie de la region sud de la province de Constantine, 1862, p. 288. L. Pervinquière, Étude géol. de la Tunisie centrale (Carte géol. de la Tunisie), 1903, p. 93 (*T. Scheuchzerianus* and *T. Desnoyersi*).

1850. *Turrilites triplicatus*, J. de C. Sowerby, in Dixon's Geology of Sussex, pp. 350 and 359, Pl. xxix., f. 16.
1861. *Turrilites costatus*, F. J. Pictet, Foss. terr. crét. Sainte-Croix, Pt. 2 (Pal. Suisse, sér. 3), livr. 5 and 6, p. 142.
1862. *Turrilites costatus*, H. Coquand, Géologie et paléontologie de la region sud de la province de Constantine, p. 288.
1866. *Turrilites costatus*, F. Stoliczka, Cret. Fauna S. India (Pal. Indica), i., Cephalopoda, p. 188, Pl. lxxxvii., f. 9, 10; Pl. lxxxviii., f. 1, 2.
1876. *Turrilites costatus*, C. Schlüter, Ceph. d. ober. deutsch. Kreide, Abth. ii., Lief. i. (Palaeontogr., Bd. xxiv., Lief. 1, May, 1876), p. 125 (5), Pl. xxxviii. (iii.), f. 1–5.
1895. *Turrilites costatus*, F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 1 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. ix., Heft iii. and iv.), p. 46 (142).
1898. *Turrilites costatus*, P. Choffat, Recueil d'Études paléont. Faune crét. Portugal, i., sér. 2, p. 51, Pl. iv., f. 3. (Comm. travaux géol. Portugal.)
1903. *Turrilites costatus*, L. Pervinquière, Étude géol. de la Tunisie centrale (Carte géol. de la Tunisie), p. 93.

Observations.—This species is certainly represented in Mr. Anderson's collection by one specimen about 42 mm. long, consisting of about three whorls, the diameters of the first and last being 16 and 25 mm. respectively; and possibly also by a small specimen, about 21 mm. long, consisting of rather more than two whorls, the diameter of the last whorl being about 14 mm.

This species is confined to the Cenomanian, and occurs in France * (where it is characteristic of that portion of the Cenomanian designated the Rotomagian), England,† Germany,‡ Switzerland,§ Spain,|| North Africa,¶ the extreme north of Madagascar,** and Southern India.†† It is found in the brown sandstone at Odiam,

* A. d'Orbigny, Pal. Franç., Terr. crét., 1840, i., p. 598, Pl. cxlv.

† D. Sharpe, Foss. Moll. Chalk (Mon. Pal. Soc.), Pt. 3, 1856, p. 66, Pl. xxvii., f. 1–5, 15, 16.

‡ C. Schlüter, Ceph. d. ober. deutsch. Kreide, Abth. ii., Lief. 1 (Palaeontogr. xxiv., Lief. 1, May, 1876), p. 125 (5).

§ F. J. Pictet, Foss. terr. crét. Sainte-Croix, Pt. 2 (Pal. Suisse, sér. 3), 1861–64, p. 142.

|| P. Choffat, Recueil d'Études paléont. Faune crét. Portugal, i., sér. 2, p. 51, Pl. iv., f. 3. (Comm. travaux géol. Portugal.)

¶ H. Coquand, Géologie et paléontologie de la region sud de la province de Constantine, 1862, p. 288. L. Pervinquière, Étude géol. de la Tunisie centrale (Carte géol. de la Tunisie), 1903, p. 93.

** P. Lemoine, Études géologiques dans le nord de Madagascar, 1906, p. 206.

†† F. Stoliczka, Cret. Fauna S. India (Pal. Indica), i., Cephalopoda, p. 188; Pl. lxxxvii., f. 9, 10; Pl. lxxxviii., f. 1, 2. F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 1 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. ix., Heft iii. and iv.), 1895, p. 46 (142).

in Southern India; and, according to Dr. Kossmat, is the commonest species of Turrilite in the Utatúr Group of Southern India, being particularly characteristic of the *Acanthoceras* beds of the middle division of that group. It has also been recorded from Tibet.*

Turrilites acutus, *Passy*.

(Pl. XI., Figs. 3, 3*a*, 4, 4*a*.)

1832. *Turrilites acutus*, C. A. Passy, Descr. géol. de la Seine-Inférieure, Pl. xvi., f. 3.
1840. *Turrilites costatus*, A. d'Orbigny, Pal. Franç., Terr. crét., i., p. 598 (pars).
1854. *Turrilites tuberculatus*, F. Roemer, Die Kreidebildungen Westfalens : Verhandl. d. naturh. Ver. d. preuss. Rheinlande und Westfalens, 1854, p. 77.
1856. *Turrilites Wiestii*, D. Sharpe, Foss. Moll. Chalk of England (Mon. Pal. Soc.), Pt. 3, p. 67, Pl. xxvii., f. 8; 9*a*, *b*; (? 14*a*, *b*); 17.
? 1856. *Turrilites costatus*, D. Sharpe, Foss. Moll. Chalk of England (Mon. Pal. Soc.), Pt. 3, Pl. xxvii., f. 1.
1861. *Turrilites costatus* (pars), F. J. Pictet, Foss. terr. crét. Sainte-Croix, Pt. 2 (Pal. Suisse, sér. 3), livr. 5 and 6, pp. 142 and 154.
1876. *Turrilites acutus*, C. Schlüter, Ceph. d. ober. deutsch. Kreide, Abth. ii., Lief. 1 (Palaeontogr., Bd. xxiv., Lief. 1, May, 1876), p. 127 (7), Pl. xxxviii. (iii.), f. 15, 16.
? 1903. *Turrilites Wiesti*, L. Pervinquière, Étude géol. de la Tunisie centrale (Carte géol. de la Tunisie), p. 93.

Observations.—To this species I refer a number of specimens in the collection. They are all rather small and fragmentary, the longest having a length of about 45 mm., the greatest diameter of the whorl, exhibited in the original of Pl. XI., Fig. 4, being 32 mm. The apical angle varies from 25°, as is seen in the longest specimen, to 41°, as shown by the original of Pl. XI., Fig. 4.

Passy founded the species upon examples from the Cenomanian of Rouen. D'Orbigny and others † united the species with Lamarck's *T. costatus*. According to Schlüter,‡ F. Roemer § recorded it from the Cenomanian of Westphalia under the name *Turrilites tuberculatus*. From the Cenomanian of England it was described

* H. H. Hayden, Records Geol. Surv. India, xxxii, 1905, p. 164.

† A. d'Orbigny, Pal. Franç., Terr. crét., 1840, i., p. 598. C. G. Giebel, Fauna der Vorwelt, Bd. iii., 1852, p. 356. H. G. Bronn, Lethæa geogn., 3 Aufl., Kreide, 1852, p. 336. F. J. Pictet, Foss. terr. crét. Sainte-Croix, Pt. 2 (Pal. Suisse, sér. 3), livr. 5 and 6, 1861, p. 142.

‡ C. Schlüter, Ceph. d. ober. deutsch. Kreide, Abth. ii., Lief. 1 (Palaeontogr., Bd. xxiv., Lief. 1, May, 1876), pp. 127–8 (7–8).

§ F. Roemer, Die Kreidebildungen Westfalens, Verhandl. d. naturh. Ver. d. preuss. Rheinlande und Westfalens, 1854, p. 77.

by Sharpe * under the name *Turrilites Wiestii*, and it is most probably this species which is recorded under the same name by Pervinquière † from the Cenomanian of Tunis. Of the species described from Southern India, that identified by Stoliczka ‡ as *Turrilites Gresslyi* (= *Turrilites circumtæniatus*, Kossmat §) from the Utatúr Group (Lower *fide* Kossmat) most closely resembles the present form. A somewhat similar but larger form has been figured by Boule ‖ as *Turrilites tuberculatus*, from the Cenomanian in the south-western part of Madagascar, where it occurs with *Acanthoceras rotomagense*; and Lemoine ¶ has recorded both *Turrilites Gresslyi* and *T. circumtæniatus* from the north of the island.

Turrilites nodiferus, *sp. nov.*

(Pl. XI., Figs. 5, 5*a*.)

Description.—Shell turreted, sinistral; whorls probably few (? exact number), externally convex and somewhat angular near the middle, with one row of fifteen or sixteen (eight in the half whorl) very large tubercles a little above their middles, and two, or possibly three, rows of numerous small tubercles on their lower part; of these rows the tubercles in the two upper ones are confluent and form almost feebly-nodose ridges, whilst the lowest row of tubercles, almost coalescing with the one immediately above it, is very obscure, and was probably partially concealed by the next whorl. Between the row of large nodes and the uppermost row of smaller tubercles, the whorl is feebly concave. The upper portion of the whorl is covered with oblique and slightly curved ribs (about twenty-seven in the half whorl), which in crossing the whorl pass from the upper suture obliquely backwards with a slight orad-concave curve as far as the uppermost row of smaller tubercles. The basal portion of the whorl is convex, and covered with radiating ribs, which arising from, and in number corresponding to, the tubercles in the lowest row, pass thence obliquely forwards into the umbilicus. The impressed zone is about one half of the width of the upper surface of the whorl. Umbilicus not very large, about two-sevenths of the corresponding diameter of the shell in width, with convex, fairly distinct margin. Whorl subpentagonal in cross-section, rounded below; about as wide as high. Septa not seen.

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* D. Sharpe, Foss. Moll. Chalk of England (Mon. Pal. Soc.), Pt. 3, 1856, p. 67, Pl. xxvii., f. 8, 9*a*, *b* (? 14*a*, *b*), 17.

† L. Pervinquière, Étude géol. de la Tunisie centrale (Carte géol. de la Tunisie), 1903, p. 93.

‡ F. Stoliczka, Cret. Fauna S. India (Pal. Indica), i., Cephalopoda, p. 186, 1866, Pl. lxxxvii., f. 1–5.

§ F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 1 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. ix., Heft iii. and iv.), 1895, p. 141.

‖ M. Boule, in Madagascar au début du xx^e^ siècle, by R. Blanchard and others, 1902, p. 53, f. 37.

¶ P. Lemoine, Études géologiques dans le nord de Madagascar, 1906, p. 206.

Dimensions.

Diameter of whorl...	54 mm.
Height of whorl at anterior end	24 mm.
Width of whorl „ „	23 mm.
Width of umbilical perforation	11 mm.
Width of umbilicus at umbilical margin ...	14 mm.

Observations.—This species is represented in Mr. Anderson's collection by only one specimen. This consists of a little more than one half of a whorl 54 mm. in diameter, and, being devoid of septa, evidently formed part of the body-chamber, which, judging from the line of suture present on the under side of the whorl, must have occupied nearly another complete whorl.

Allowing for the difference in nomenclature—Stoliczka having in his descriptions of Turrilites taken the reversed cone as the position of the shell, instead of the probably natural position with the mouth downwards—the present species is seen to very closely resemble Stoliczka's *Turrilites Cunliffeanus*,* which was founded upon a single specimen obtained from the Utatúr Group† at Odiam, in Southern India. The type-specimen consisted of about one and a half whorls, and attained a diameter of nearly 150 mm., its distinctive characters, as compared with other known species, being, according to Stoliczka, "the peculiar ornamentation,‡ consisting of the three rows of tubercles," "and the curved ribs." The African species has precisely similar ornaments, but compared with the Indian form the upper part of the whorl is relatively more inflated, the radiating ribs on the basal area are straighter, and the umbilicus is relatively smaller; nevertheless the similarity between the two forms is very remarkable. Amongst European species its nearest ally is probably *Turrilites Gravesianus*, d'Orbigny,§ but this lacks the costæ on the upper part of the whorl.

* F. Stoliczka, Cret. Fauna S. India (Pal. Indica), i., Cephalopoda, p. 190, 1866, Pl. lxxxix., f. 1, 1*a*. Stoliczka speaks of the shell as being "ornamented partly with" "tubercles, partly with ribs," and then says: "The former occupy the upper portion of" "the outer circumference, and are arranged in three rows so as to be like granular" "zones." The tubercles here referred to appear to be the rows indicated on the lower part of the whorl in f. 1, so that to agree with Stoliczka's descriptions f. 1 should be inverted; only two such rows, however, are represented in f. 1. There may be three in the basal view depicted in f. 1*a*, but this is a little doubtful. The "close oblique" "costæ" on "the lower half portion" are evidently the costæ indicated on the upper part of the whorl as it is represented in f. 1. Although no reference is made to the large tubercles at about the middle of the whorl, these are clearly shown in his f. 1.

† Middle Utatúr *fide* F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 1 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. ix., Heft iii. and iv.), 1895, p. 46 (142).

‡ In his description Stoliczka makes no reference to the large tubercles at about the middle of the whorl, but these are clearly shown in one of his figures (f. 1).

§ A. d'Orbigny, Pal. Franç., Terr. crét., 1840, i., p. 596, Pl. 144, f. 3–5. See also D. Sharpe, Foss. Moll. Chalk of England (Mon. Pal. Soc.), Pt. 3, 1856, p. 62, Pl. xxv., f. 7; Pl. xxvi., f. 14.

5. Genus Baculites, *Lamarck.*

(Mém. Soc. d'hist. nat., 1799, p. 80.)

Baculites, *sp.*

Observations.—This genus may be represented by a fragment imbedded in the infilling of one of the chambers of the example of *Nautilus striaticostatus* figured in Pl. XIV., Figs. 7, 7*a*. The fragment, a natural internal cast, does not show any trace of septa, is about 10 mm. long, nearly cylindrical, and appears to have had a circular or subcircular transverse section, but is too obscure for specific identification. It might be a fragment of such a form as that figured as *Baculites teres* by Stoliczka, *op. cit.*, Pl. xc., f. 13,* from the Utatúr Group of Odiam, in the Trichinopoli district of Southern India.

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6. Genus Knemoceras, *J. Böhm.*

(Zeitschr. Deutsch. geol. Gesell., Bd. l. (1898), p. 200.†)

Knemoceras (?) cornutum, *sp. nov.*

(Pl. X., Figs. 16, 16*a*, 16*b*.)

Observations.—To this genus is doubtfully referred a fragment of a whorl. This is subtriangular in transverse section, being at its mid-length 23 mm. high (spines not included) and 15 mm. wide, the greatest width being at about three-sevenths of the height of the whorl from the umbilicus; the impressed zone is about 6 mm. wide. The shell, judging from the umbilical edge, which appears to be perfect on one side (see Fig. 16), seems to have had an open, but not very wide, umbilicus; the margin of the umbilicus bears transversely elongated nodes, which do not appear to have been continued far on to the lateral area; the sides feebly undulate, their surface being smooth; the periphery is narrowly convex, but at intervals each margin is raised into a very much flattened longitudinally-elongated tubercle (see Fig. 16*b*); the tubercles are opposite, about 7·5 mm. apart measured across the periphery, each pair being raised somewhat above the general level of the periphery, and separated not quite so far from the preceding pair as their width apart; anteriorly the fragment exhibits a portion of the septal surface (see Fig. 16*a*).

The fragment is quite unlike any other specimen in the collection. It bears some resemblance to the genus *Placenticeras*, but its suture-line does not possess the numerous lobes and saddles found in that genus. It does not agree with any of the species referred

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* Not *Baculites teres*, Forbes, but *Baculites sp. ?*, *fide* F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 1 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. ix., Heft iii. and iv.), 1895, p. 58 (154).

† See footnote, *antea*, p. 165; and also A. Hyatt, Pseudoceratites of the Cretaceous, Mon. U.S. Geol. Surv., xliv., 1903, p. 145.

to that genus either by Etheridge* from the Umkwelane Hill Deposit, or by Blanford, Stoliczka, and Kossmat† from the Cretaceous rocks of Southern India. In those species we note also that the tubercles on the periphery alternate and are not opposite.

Its characters, however, are so distinctive that notwithstanding its imperfection we have ventured to give it the trivial name *cornutum*, and to refer it doubtfully to the genus *Knemoceras*. It seems to be related to *K. syriacum*. v. Buch, sp.

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7. Genus Forbesiceras, *Kossmat*.

(Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. xi., Heft iii., 1898, p. 125.)

In 1895 the genus *Discoceras* was proposed by Dr. Kossmat‡ for the following three species: (1) *Ammonites Largilliertianus*, d'Orbigny § (= *Ammonites complanatus*, Mantell), from the Cenomanian of France, England, and Southern India; (2) *Ammonites obtectus*, Sharpe,‖ from the Cenomanian of England; and (3) *Ammonites subobtectus*, Stoliczka,¶ from the Cenomanian of Southern India. Finding that the name *Discoceras* was preoccupied, Dr. Kossmat subsequently altered the name to *Forbesiceras*. In a review of Dr. Kossmat's work in the *Revue de Paléozoologie*, January, 1898, Dr. E. Haug also pointed out (p. 50) that the name *Discoceras* was preoccupied, and substituted for it (p. 78) the name *Cenomanites*. The part of the publication containing Dr. Kossmat's alteration of the name, although dated on the wrapper 1897, did not, according to the table of contents of the volume, appear until January, 1898; but whether the name *Forbesiceras* be actually antedated or not by Dr. Haug's name, we think that in the circumstances most writers will adopt the alteration suggested by the author himself.

The genus is represented in the present collection by four fragmentary specimens which appear to be referable to three distinct species.

Forbesiceras Largilliertianum, *d'Orbigny*, *sp.*

(Pl. XI., Figs. 6, 6*a*.)

1822. *Ammonites complanatus*, G. A. Mantell, Foss. S. Downs, p. 118 (*non* Bruguière).

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* R. Etheridge, Second Report Geol. Surv. Natal, 1904, p. 89.

† For references see F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. i. (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. ix., Heft iii. and iv.), 1895, pp. 78 (174) –80 (176).

‡ F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. i. (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. ix., Heft iii. and iv.), 1895, p. 179.

§ A. d'Orbigny, Pal. Franc., Terr. crét., 1840, i., p. 320, Pl. xcv.; D. Sharpe, Foss. Moll. Chalk S. England (Mon. Pal. Soc.), Pt. i., 1853, p. 19, Pl. vii., f. 1–3, and F. Stoliczka, Cret. Fauna S. India (Pal. Indica), i., Cephalopoda, p. 94, 1864, Pl. xlix., f. 1.

‖ D. Sharpe, Foss. Moll. Chalk S. England (Mon. Pal. Soc.), Pt. i., 1853, p. 20, Pl. vii., f. 4.

¶ F. Stoliczka, Cret. Fauna S. India. (Pal. Indica), i., Cephalopoda, p. 96, 1864, Pl. xlix., f. 2.

1827. *Ammonites complanatus*, J. de C. Sowerby, Min. Conch., vi., p. 133, Pl. dlxix., f. 1.
1840. *Ammonites Largilliertianus*, A. d'Orbigny, Pal. Franç., Terr. crét., i., p. 320, Pl. xcv.
1850. *Ammonites subcomplanatus*, A. d'Orbigny, Prod. de Paléont., ii., p. 146.
1853. *Ammonites complanatus*, D. Sharpe, Foss. Moll. Chalk (Mon. Pal. Soc.), Pt. i., p. 19, Pl. vii., f. 1–3.
1860. *Ammonites Largilliertianus*, F. J. Pictet, Foss. terr. crét. Sainte-Croix, Pt. i. (Pal. Suisse, sér. 2), p. 257.
1864. *Ammonites Largilliertianus*, F. Stoliczka, Cret. Fauna S. India (Pal. Indica), i., Cephalopoda, p. 94, Pl. xlix. f. 1.
1895. *Discoceras Largilliertianum*, F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. i. (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. ix., Heft iii. and iv.), p. 84 (180), Pl. viii. (xxii.), f. 6*a*, *b*, *c*.
1898. *Forbesiceras Largilliertianum*, F. Kossmat, *op. cit.*, Pt. iii. (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. xi., Heft iii.), p. 190 (125).
1903. *Forbesiceras Largilliertianum*, L. Pervinquière, Étude géol. de la Tunisie centrale (Carte géol. de la Tunisie), p. 93.

Observations.—A fragment in Mr. Anderson's collection is referable to this species. It is a little more than one-fourth of a whorl and about 50 mm. long measured along the median line of the periphery, the height and thickness of the whorl at the anterior end being 34 and 14 mm. respectively. There are no indications of the suture-line, so that the specimen may have formed part of the body-chamber. Another much larger, but completely-septate, fragment probably also belongs to this species. This specimen measures rather more than 115 mm. along the median line of the periphery, the height of the whorl at the anterior end being about 58 mm. and the greatest thickness 23 mm.; it is much crushed and the surface badly preserved, but at the posterior end, on one side and near the periphery, a small piece of the test with its characteristic sculpture is preserved.

Forbesiceras Largilliertianum, first described by d'Orbigny from the Cenomanian of France, occurs also in the Cenomanian of England*; the Cenomanian of Tunis†; and in the Cenomanian (Utatúr Group) of Southern India.‡

* G. A. Mantell, Foss. S. Downs, 1822, p. 118 (*Ammonites complanatus*); D. Sharpe, Foss. Moll. Chalk (Mon. Pal. Soc.), Pt. i., 1853, p. 19, Pl. vii., f. 1–3 (*Ammonites complanatus*).

† L. Pervinquière, Étude géol. de la Tunisie centrale (Carte géol. de la Tunisie), 1903, p. 93.

‡ F. Stoliczka, Cret. Fauna S. India (Pal. Indica), i., Cephalopoda, p. 96, Pl. xlix., f. 1; and F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. i. (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. ix., Heft iii. and iv.), 1895, p. 84 (180), Pl. viii. (xxii.), f. 6*a*, *b*, *c*.

FORBESICERAS SCULPTUM, *sp. nov.*

(Pl. XI., Figs. 7, 7*a*.)

Observations.—Another species of *Forbesiceras* is indicated by a fragment consisting of about one-fourth of a whorl. The sculpture of this specimen is much coarser than that of *Forbesiceras Largillierti-anum*, and in fact much more nearly approaches that of *Forbesiceras obtectum*, Sharpe, sp.* The whorl is much compressed, with feebly convex sides, and a relatively narrow truncated periphery; it is ornamented on the sides with numerous flat ribs, which, rising at the umbilicus, slope forward to about the middle of the lateral area, whence they bend back slightly and pass with a feeble forwardly-concave curve to the margin of the periphery, where each projects in a compressed longitudinally-elongated tubercle; the ribs on the outer half of the lateral area are much coarser than on the inner, and have an imbricated appearance, the anterior portion of each rib being depressed below the posterior margin of the preceding rib; near the posterior end of the specimen there may have been on each rib, near its bend at about the middle of the lateral area, a very feeble tubercle, but this is by no means certain; no such tubercle can be seen on the anterior part of the specimen; the periphery is narrow, truncated, bounded on each side by a row of compressed longitudinally-elongated tubercles formed by the projecting ends of the ribs; it is feebly convex in the middle and feebly concave between the median line and each tuberculated margin; the ribs are faintly visible on the periphery, which they cross in a feeble forwardly-concave curve, some of them exhibiting faint indications of subdivision into two narrower ribs. In this specimen, which is a natural cast bearing only fragments of the test, there is a very minute umbilicus, but in the original shell this was doubtless closed. At the anterior end of the specimen the whorl, which has its greatest thickness at a short distance from the umbilicus, is 32 mm. high and 12 mm. thick, the periphery, measured between the marginal tubercles, being here 6·5 mm. wide. The suture-line is not preserved.

This specimen finds its nearest ally in *Forbesiceras obtectum*, Sharpe, sp., from which it differs, however, by its much coarser sculpture, and possibly also by the absence of nodes on the median portion of the lateral area of the adult. Although very imperfect it seems desirable to name the specimen, so the trivial name *sculptum* is here proposed for it. Sharpe's species was founded upon a unique specimen from the "Chalk with siliceous grains" (Cenomanian) of Chardstock, Dorset.

FORBESICERAS NODOSUM, *sp. nov.*

(Pl. XI., Figs. 8, 8*a*, 8*b*, 8*c*.)

Observations.—Yet another species of *Forbesiceras* is indicated by the fragment of a whorl, which, when complete, must have been about

* D. Sharpe, Foss. Moll. Chalk (Mon. Pal. Soc.), Pt. i., 1853, p. 20, Pl. vii., f. 4.

110 mm. in diameter. As the specimen is entirely septate, the species must have reached a considerable size. Of the species of *Forbesiceras* that have been already described, this fragment is most closely allied to *Forbesiceras subobtectum*, Stoliczka, sp.* The fragment shows that the shell was discoidal, much compressed, with feebly convex sides, a minute umbilicus, and a relatively narrow truncated periphery. The transverse section of the whorl (Pl. XI., Fig. 8*a*) is elongated-elliptical, its greatest thickness being at about the middle of the lateral area. At about the middle of the specimen the whorl has the following measurements: Height, 57 mm.; greatest thickness, 28 mm.; width of periphery (measured between marginal tubercles), 12 mm. The outer half of the lateral area is ornamented with broad, flat, imbricating ribs extending from the middle of the side in a feeble, forwardly-concave curve to the margin of the periphery, where each forms a compressed longitudinally-elongated tubercle. At the posterior part of the specimen each alternate rib is continued by an almost straight and relatively narrow rounded rib on to the inner half of the whorl, but the ultimate course of these ribs is obscured in the present example. The greater part of the inner portion of the lateral area is smooth; at about the middle of the lateral area there is a row of obtuse transversely-elongated nodes, not quite half so numerous as the ribs on the outer portion of the lateral area, but these nodes are wanting on the posterior part of the specimen. The periphery (Pl. XI., Fig. 8*b*) is narrow, convex, crossed by numerous small rounded and equidistant ribs, and bounded on each side by the compressed tuberculated ends of the ribs on the lateral area. At the anterior part of the specimen (Pl. XI., Fig. 8*c*) three, and at the posterior part (Pl. XI., Fig. 8*b*) two, of the peripheral ribs occupy the width of each lateral rib. The suture-line is imperfectly preserved.

The present specimen can be easily distinguished from *Forbesiceras subobtectum*, Stoliczka, sp., its nearest ally, by the character of the ornaments on the outer portion of the lateral area.

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8. Genus Acanthoceras, *Neumayr.*

(Zeitschr. Deutsch. geol. Gesell., Bd. xxvii., 1875, p. 929.)

Although this genus is admittedly heterogeneous, it has been considered advisable to adopt it in the following pages, the revision of the genus entailing work which does not fall within the scope of the present paper. The genus is well represented in the collection. Most of the forms belong to the group of *Acanthoceras rotomagense*, but one may be referable to the group of *Acanthoceras colerunense*.

* F. Stoliczka, Cret. Fauna S. India (Pal. Indica), i., Cephalopoda, p. 96, 1864, Pl. xlix., f. 2

(*a*) Group of ACANTHOCERAS ROTOMAGENSE,* *Brongniart, sp.* †

This group is rather numerously represented in Mr. Anderson's collection. Usually a difficult group to deal with, the difficulties are here increased by the condition of the specimens and the frequent obscurity of the suture-lines. The examples which are fairly well preserved consist usually of the inner whorls only; the larger specimens are generally fragments only of the outer whorls, and it is therefore difficult to know to which of the younger specimens these fragments should be assigned. Several species, however, seem to be well marked off, but the most difficult to determine are those most nearly related to the species *rotomagensis*. It is most probable that amongst these there are several different species represented, although their limits are hard to define. This is partly due to the various interpretations which have been given to Brongniart's species. We have, however, selected several apparently quite distinct types.

In Eastman's translation of Zittel's "Text-book of Palaeontology," 1900, i., p. 589, Hyatt institutes the genus *Metacanthoplites* without any description, merely giving as the type "*M.* (*Amm.*) *rotomagensis*," "d'Orb., sp."

ACANTHOCERAS FLEXUOSUM, *sp. nov.*

(Pl. XII., Figs. 1, 1*a*.)

Description.—Shell discoidal, umbilicated, with a few quadrangular rapidly-increasing whorls; greatest thickness at a short distance from the umbilical margin, about one-half of the diameter of the shell; height of outer whorl a little less than one-half of the diameter of the shell. Whorls probably few (? exact number); inclusion about one-third; umbilicus with steep walls and well-defined rounded margin, fairly deep, a little less than one-fourth of the diameter of the shell in width. Whorl subquadrangular in transverse section, a little wider than high; feebly indented by the preceding whorl; periphery flattened, each margin indicated by a row of longitudinally-elongated tubercles; sides flattened, nearly parallel, bevelled near the periphery, forming a well-marked ventral lateral zone; umbilical zone well defined, convex, almost perpendicular to the mesal plane of the shell. Body-chamber apparently occupying at least half a whorl; aperture not seen. Depth of chambers unknown; suture-line imperfectly known—septal surface showing ventral lobe not very narrow; the external saddle very large; the first lateral lobe rather narrow, short, and apparently trifid; the first lateral saddle rather small; the second lateral lobe apparently trifid and situated close to the umbilical margin; the second lateral saddle small and placed on the umbilical margin; two small lobes

* We have adopted the spelling of the name of this species now usually employed. See A. de Grossouvre, Recherches sur la craie supérieure, Pt. 1, Stratigraphie générale, 1901, p. 979. (Mém. Carte géol. detailée de la France.)

† A. Brongniart, in G. Cuvier, Ossemens fossiles, 4th ed., 1834, iv., p. 636, Pl. *N*, f. 2*A*, *B*. Brongniart attributes the name to Defrance, but the latter does not appear to have published the name.

on the inner area of the whorl or umbilical zone. Test ornamented with about twenty-six slightly flexuous ribs per whorl; these are directed slightly forwards as they cross the whorl, turning still more forwards as they pass over the ventral lateral zone, and then passing straight, or with only a very feeble forwardly-convex curve, across the periphery; they are narrow near the umbilical margin, but become flatter and broader as they approach and cross the periphery; some of these (usually, but not always, the alternate ones) are very prominent (though scarcely tuberculated) at the umbilical margin; each rib bears a feeble longitudinally-elongated tubercle at the centre of the periphery, a larger longitudinally-elongated tubercle on each peripheral margin placed somewhat obliquely, and a similarly-placed, but rather smaller, longitudinally-elongated tubercle on the lateral area at a distance from the peripheral margin of about one-half the width of the periphery. On the inner whorls the prominent portions of the ribs on the umbilical margin are relatively larger, further apart, and almost tuberculate.

Dimensions.

Diameter of shell	...	...	75 mm. (1)
Height of outer whorl	...	...	36 mm. (0·48)
Thickness of outer whorl	...	...	38 mm. (0·50)
Width of umbilicus	...	...	19 mm. (0·25)

Observations.—The example in Mr. Anderson's collection illustrating this species is entirely septate, but bears traces of having possessed rather more than another half whorl, which seems to have been mainly occupied by the body-chamber; the median peripheral tubercle is quite distinct at the anterior end of the specimen. It closely resembles the specimen from the Grey Chalk of Bonchurch, Isle of Wight, figured as *Ammonites rotomagensis* by Sharpe, Foss. Moll. Chalk of England (Mon. Pal. Soc.), Pt. 2, 1854, Pl. xvi., f. 2*a*, *b*,* but has the outer whorl relatively higher, the dimensions of Sharpe's specimen, taken from the original, being as follows: Diameter of shell, 72 mm. (1); height of outer whorl, 32·5 mm. (0·45); thickness of outer whorl, 38 mm. (0·52); width of umbilicus, 19·5 mm. (0·27). Dr. Kossmat † regards Sharpe's specimen as intermediate between *Acanthoceras Newboldi* and *Acanth. Newboldi* var. *spinosa*, both occurring in the Middle Utatúr group of Southern India, but probably nearer the typical form; it differs, however, from the forms here referred to that species and variety,‡ in having the ribs more flexuous and more forwardly-inclined as they cross the lateral area from the umbilical margin.

ACANTHOCERAS CRASSIORNATUM, *sp. nov.*

Description.—Shell discoidal, umbilicated, with a few rapidly-

* Specimen in Mus. Geol. Soc., London, R. 7758.

† F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 2 (Beitr. zur. Paläont. u. Geol. Österr.-Ungarns, &c., Bd. xi., Heft i.), 1897, p. 113 (6).

‡ See *postea*, pp. 197, 199.

increasing quadrangular whorls; greatest thickness near the umbilical margin, about one-half of the diameter of the shell; height of outer whorl a little less than one-half of the diameter of the shell. Whorls probably few (? exact number); inclusion about one-third; umbilicus not very deep, with convex walls and broadly-convex margin, nearly one-fourth of the diameter of the shell in width. Whorl trapezoidal in transverse section, a little wider than high; indented to about one-fifth of its height by the preceding whorl; periphery flattened, each margin indicated by a row of sharp longitudinally-elongated tubercles, placed a little obliquely; sides flattened, bevelled near the periphery, feebly convergent; umbilical zone steep, convex, ill-defined from the lateral area. Body-chamber apparently occupying at least half a whorl; aperture not seen. Depth of chambers unknown; suture-line imperfectly known—septal surface only partially seen. Test ornamented with from twenty-one to twenty-two slightly flexuous ribs per whorl; these cross the lateral area in an almost radial direction, becoming broader and much more obscure on the outer portion of the area, then, turning forward at the row of tubercles on the lateral area, they pass in a forward direction to the margin of the periphery and then cross the peripheral area as broad, obscure bands, having a feebly orad-convex curve; the umbilical portion of some of the ribs (usually, but not always, the alternate ones) is very prominent, but not tuberculated; each rib bears a longitudinally-elongated tubercle at the centre of the periphery that, as the shell advances in age, becomes very obscure and almost continuous with the preceding and succeeding tubercles, a very prominent longitudinally-elongated tubercle obliquely placed at each margin of the periphery, and on the lateral area, at a distance of about half the width of the peripheral area from the margin of the periphery, a similar but slightly smaller tubercle.

Dimensions.

Diameter of shell ...	...	...	78 mm. (1)
Height of outer whorl	...	...	36 mm. (0·46)
Thickness of outer whorl	...	...	39 mm. (0·50)
Width of umbilicus...	...	...	20 mm. (0·25)

Observations.—The specimen having the dimensions given above is entirely septate, but there are traces of about another half whorl which seems to have been almost entirely occupied by the body-chamber. Possibly to this species must also be referred a series of examples ranging in diameter from 37 mm. to 70 mm., but they are very imperfectly preserved; whilst another specimen, 50 mm. in diameter, appears by its sculpture to be intermediate between the present species and *Acanthoceras flexuosum*. From *Acanthoceras flexuosum*, its nearest ally, the present species is distinguished by its coarser ornaments, its less clearly defined umbilical margin, and its more rapidly increasing (transversely) whorls.

ACANTHOCERAS MUNITUM, *sp. nov.*

Description.—Shell discoidal, umbilicated, rather robust, with a few rather rapidly-increasing whorls; greatest thickness near the umbilical margin, a little more than one-half of the diameter of the shell; height of outer whorl a little less than one-half of the diameter of the shell. Whorls few (? exact number); inclusion about three-sevenths; umbilicus rather deep, with steep sides and convex margin, about one-fourth of the diameter of the shell in width. Body-chamber about one-half of a whorl in length; aperture not seen. Chambers rather shallow; suture-line with ventral lobe fairly wide and deep; external saddle broad and deeply bifid; first lateral lobe rather narrow, trifid, and situated on the middle of the lateral area; the first lateral saddle narrow and placed close to the umbilical margin; the second lateral lobe on the umbilical margin; the second lateral saddle very small and situated on the umbilical zone of the whorl. Whorl trapezoidal in transverse section, rather wider than high; indented to about one-sixth of its height by the preceding whorl; periphery flattened, feebly convex, bounded on each side by a row of longitudinally-elongated obliquely-set tubercles; sides flattened, a little convergent, bevelled near the peripheral margin, ill-defined from the umbilical zone; umbilical zone steep, convex, almost perpendicular to the mesal plane of the shell. Test ornamented with alternately long and short ribs; the longer ribs arising at the suture of the shell pass in a slightly-backward direction over the umbilical zone on to the umbilical margin, then turning forward they nearly cross the lateral area in an almost radial direction, turning again, however, sharply forward shortly before reaching the peripheral margin, they pass obliquely forward as far as that margin and cross the periphery in a broad, flattened orad-convex curve, exhibiting there a tendency to subdivision in the later stages of growth; the shorter ribs, arising at about the middle of the lateral area, cross the whorl in a similar direction; each rib bears a row of well-marked longitudinally-elongated tubercles along the median line of the periphery, a row of rather larger similarly-elongated obliquely-set tubercles on each peripheral margin, and a similar row of tubercles on the lateral area at about one-half the width of the periphery from the peripheral margin; the umbilical portion of each of the longer ribs is very prominent in the early stages of growth, but as growth proceeds becomes much more so by the development of a strong, compressed spine; the test is also ornamented with rather coarse lines of growth.

Dimensions.

	(*a*)	(*b*)	(*c*)	(*d*)
Diameter of shell	65·0 mm. (1)	57·0 mm. (1)	43 mm. (1)	42·5 mm. (1)
Height of outer whorl	32·0 mm. (0·49)	26·0 mm. (0·45)	21 mm. (0·49)	20·0 mm. (0·47)
Thickness of outer whorl	36·5 mm. (0·56)	31·5 mm. (0·55)	24 mm. (0·56)	23·0 mm. (0·54)
Width of umbilicus	16·0 mm. (0·24)	14·5 mm. (0·25)	11 mm. (0·25)	11·0 mm. (0·26)

Observations.—In the present species, which is one of the few species in which the suture-lines are tolerably well shown, are included

increasing quadrangular whorls; greatest thickness near the umbilical margin, about one-half of the diameter of the shell; height of outer whorl a little less than one-half of the diameter of the shell. Whorls probably few (? exact number); inclusion about one-third; umbilicus not very deep, with convex walls and broadly-convex margin, nearly one-fourth of the diameter of the shell in width. Whorl trapezoidal in transverse section, a little wider than high; indented to about one-fifth of its height by the preceding whorl; periphery flattened, each margin indicated by a row of sharp longitudinally-elongated tubercles, placed a little obliquely; sides flattened, bevelled near the periphery, feebly convergent; umbilical zone steep, convex, ill-defined from the lateral area. Body-chamber apparently occupying at least half a whorl; aperture not seen. Depth of chambers unknown; suture-line imperfectly known—septal surface only partially seen. Test ornamented with from twenty-one to twenty-two slightly flexuous ribs per whorl; these cross the lateral area in an almost radial direction, becoming broader and much more obscure on the outer portion of the area, then, turning forward at the row of tubercles on the lateral area, they pass in a forward direction to the margin of the periphery and then cross the peripheral area as broad, obscure bands, having a feebly orad-convex curve; the umbilical portion of some of the ribs (usually, but not always, the alternate ones) is very prominent, but not tuberculated; each rib bears a longitudinally-elongated tubercle at the centre of the periphery that, as the shell advances in age, becomes very obscure and almost continuous with the preceding and succeeding tubercles, a very prominent longitudinally-elongated tubercle obliquely placed at each margin of the periphery, and on the lateral area, at a distance of about half the width of the peripheral area from the margin of the periphery, a similar but slightly smaller tubercle.

Dimensions.

Diameter of shell ...	...	...	78 mm. (1)
Height of outer whorl	...	...	36 mm. (0·46)
Thickness of outer whorl ...		...	39 mm. (0·50)
Width of umbilicus...	...	...	20 mm. (0·25)

Observations.—The specimen having the dimensions given above is entirely septate, but there are traces of about another half whorl which seems to have been almost entirely occupied by the body-chamber. Possibly to this species must also be referred a series of examples ranging in diameter from 37 mm. to 70 mm., but they are very imperfectly preserved; whilst another specimen, 50 mm. in diameter, appears by its sculpture to be intermediate between the present species and *Acanthoceras flexuosum.* From *Acanthoceras flexuosum*, its nearest ally, the present species is distinguished by its coarser ornaments, its less clearly defined umbilical margin, and its more rapidly increasing (transversely) whorls.

ACANTHOCERAS MUNITUM, *sp. nov.*

Description.—Shell discoidal, umbilicated, rather robust, with a few rather rapidly-increasing whorls; greatest thickness near the umbilical margin, a little more than one-half of the diameter of the shell; height of outer whorl a little less than one-half of the diameter of the shell. Whorls few (? exact number); inclusion about three-sevenths; umbilicus rather deep, with steep sides and convex margin, about one-fourth of the diameter of the shell in width. Body-chamber about one-half of a whorl in length; aperture not seen. Chambers rather shallow; suture-line with ventral lobe fairly wide and deep; external saddle broad and deeply bifid; first lateral lobe rather narrow, trifid, and situated on the middle of the lateral area; the first lateral saddle narrow and placed close to the umbilical margin; the second lateral lobe on the umbilical margin; the second lateral saddle very small and situated on the umbilical zone of the whorl. Whorl trapezoidal in transverse section, rather wider than high; indented to about one-sixth of its height by the preceding whorl; periphery flattened, feebly convex, bounded on each side by a row of longitudinally-elongated obliquely-set tubercles; sides flattened, a little convergent, bevelled near the peripheral margin, ill-defined from the umbilical zone; umbilical zone steep, convex, almost perpendicular to the mesal plane of the shell. Test ornamented with alternately long and short ribs; the longer ribs arising at the suture of the shell pass in a slightly-backward direction over the umbilical zone on to the umbilical margin, then turning forward they nearly cross the lateral area in an almost radial direction, turning again, however, sharply forward shortly before reaching the peripheral margin, they pass obliquely forward as far as that margin and cross the periphery in a broad, flattened orad-convex curve, exhibiting there a tendency to subdivision in the later stages of growth; the shorter ribs, arising at about the middle of the lateral area, cross the whorl in a similar direction; each rib bears a row of well-marked longitudinally-elongated tubercles along the median line of the periphery, a row of rather larger similarly-elongated obliquely-set tubercles on each peripheral margin, and a similar row of tubercles on the lateral area at about one-half the width of the periphery from the peripheral margin; the umbilical portion of each of the longer ribs is very prominent in the early stages of growth, but as growth proceeds becomes much more so by the development of a strong, compressed spine; the test is also ornamented with rather coarse lines of growth.

Dimensions.

	(*a*)	(*b*)	(*c*)	(*d*)
Diameter of shell	65·0 mm. (1)	57·0 mm. (1)	43 mm. (1)	42·5 mm. (1)
Height of outer whorl	32·0 mm. (0·49)	26·0 mm. (0·45)	21 mm. (0·49)	20·0 mm. (0·47)
Thickness of outer whorl	36·5 mm. (0·56)	31·5 mm. (0·55)	24 mm. (0·56)	23·0 mm. (0·54)
Width of umbilicus	16·0 mm. (0·24)	14·5 mm. (0·25)	11 mm. (0·25)	11·0 mm. (0·26)

Observations.—In the present species, which is one of the few species in which the suture-lines are tolerably well shown, are included

a small group of very spiny examples bearing considerable resemblance to the form here described as *Acanthoceras crassiornatum* * ; but compared with that species, as the dimensions given above show, they are relatively thicker and possess somewhat finer ribs, as well as more prominent and less elongated spines. The largest specimen, 65 mm. in diameter, is entirely septate, but bears traces of rather more than another half whorl, probably mostly occupied by the body-chamber; near its anterior end the umbilical portion of the longer ribs and their attendant spines are strongly developed. Compared with *Acanthoceras crassiornatum* the present species is more robust, and its tubercles sharper and more prominent; whilst compared with *Acanthoceras expansum* it is a less rapidly-increasing shell, with a wider umbilicus, much more prominent spines near the umbilical margin, and more strongly developed lateral spines near the margin of the periphery.

ACANTHOCERAS EXPANSUM, *sp. nov.*

Description.—Shell discoidal, umbilicated, with a few subangular rapidly-increasing whorls; greatest thickness near the umbilical margin, about one-half of the diameter of the shell; height of outer whorl a little less than one-half of the diameter of the shell. Whorls few (? exact number); inclusion about one-third; umbilicus fairly deep, with steep sides and broadly-convex margin, about two-sevenths of the diameter of the shell in width. Body-chamber occupying apparently about half a whorl; aperture not seen. Chambers (? depth); suture-line imperfectly known, septal surface only partially seen. Whorl quadrate in transverse section, a little wider than high; indented to about one-sixth of its height by the preceding whorl; periphery flattened, bounded on each side by a row of longitudinally-elongated tubercles; sides flattened, almost parallel, rather abruptly rounded near the peripheral margin, not sharply defined from the umbilical zone; umbilical zone steep, broadly-convex, its innermost portion nearly perpendicular to the mesal plane of the shell. Test ornamented with alternately long and short slightly flexuous ribs, the alternation not quite regular on the earlier whorls; the longer ribs arising near the suture of the shell pass in a feebly orad-concave curve over the umbilical zone on to the umbilical margin, whence they pass in an almost radial direction across the greater part of the lateral area; then passing obliquely forward as far as the peripheral margin, they cross the periphery in a broad flattened orad-convex curve; the shorter ribs arising on the lateral area cross the whorl in a similar direction; each rib bears a row of longitudinally-elongated tubercles along the median line of the periphery, a row of rather larger similarly-elongated obliquely-set tubercles on each peripheral margin, and a similar row of tubercles on the lateral area at about half the width of the periphery from the peripheral margin; in the early stages of growth the longer ribs are fairly prominent right across the lateral area, their umbilical

* See *antea*, p. 185.

portions being only a little more pronounced than the rest, but as growth proceeds the umbilical portion gets more prominent and acute, and develops a strong compressed spine, whilst the rest of the rib becomes much broader and flatter; the shorter ribs also with growth get much broader and flatter. The lateral tubercles near the peripheral margin increase greatly in size, and become more nearly in a line with the periphery.

Dimensions.

Diameter of shell	64·0 mm. (1)
Height of outer whorl	29·0 mm. (0·45)
Thickness of outer whorl (excluding spines)	30·0 mm. (0·47)
Thickness of outer whorl (including spines)	33·0 mm. (0·51)
Width of umbilicus	18·5 mm. (0·28)

Observations.—The present species is based upon an entirely septate specimen, of which the dimensions are given above. It bears a great resemblance to the largest of the examples here referred to *Acanthoceras munitum*,* but its whorls expand more rapidly, especially in a transverse direction, and the great development of the umbilica portion of the longer ribs, with their attendant spines, not only commences at an earlier stage, but is carried to a greater extent, whilst the spines near the margin of the lateral area are relatively more strongly developed than the spines on the margin of the periphery, causing the outer surface of the whorl to appear flatter and wider than in that species, and thus to approach more closely the form here described as *Acanthoceras latum*. †

ACANTHOCERAS ROBUSTUM, *sp. nov.*

Description.—Shell discoid, rather large, umbilicated, with rapidly-increasing whorls; greatest thickness at a short distance from the umbilical margin, a little less than one-half of the diameter of the shell; height of outer whorl about two-fifths of the diameter of the shell. Whorls probably few (? exact number); inclusion about three-sevenths; umbilicus rather deep, with steep convex walls and broadly-rounded ill-defined margin, about two-sevenths of the diameter of the shell in width. Whorl subquadrate in transverse section, rather wider than high; indented to about one-fifth of its height by the preceding whorl; periphery broadly convex, flattened, bounded on each side by a row of obscure, very much longitudinally-elongated tubercles; sides moderately inflated, with a ventral lateral zone, which with growth becomes almost continuous with the periphery, not sharply-defined from the umbilical zone; umbilical zone broad, convex, not sharply defined from the lateral area, its innermost portion nearly perpendicular to the mesal plane of the shell. Body-chamber occupying rather more than half a

* See *antea*, p. 187. † See *postea*, p. 195.

whorl; aperture not seen. Chambers not very deep; suture-line imperfectly known—ventral lobe rather long and not very narrow; external saddle broad and bifid; first lateral lobe narrow, trifid, and situated on the middle of the lateral area; first lateral saddle about as broad as the first lateral lobe; the second lateral lobe narrow, short, and situated on the umbilical margin or shoulder; the second lateral saddle small and, with two auxiliary lobes, situated on the umbilical zone. Test ornamented with nineteen or twenty coarse, slightly flexuous ribs per whorl; these, arising at the suture of the shell, are directed slightly backwards as they cross the umbilical zone on to the umbilical margin; thence they pass in a nearly radial direction as far as the edge of the ventral lateral zone, where they turn forwards, passing obliquely to the peripheral margin, and forming on the periphery broad obscure undulations; each rib bears five tubercles, one at the centre and one on each margin of the periphery, and one on the lateral area at a short distance from the peripheral margin; the median peripheral tubercles are narrow, obscure, greatly elongated, and as the shell approaches the adult stage become nearly continuous, almost forming an obscure median keel; the tubercles on each peripheral margin are also very much elongated, slightly raised, more prominent than the median tubercles, but with age become much more obscure, relatively narrower and more elongated; the longitudinally-elongated lateral tubercles, which in the earlier stages of growth are of about the same size as those on the peripheral margin, increase rapidly with the growth of the shell, the ventral lateral zone becoming less distinctly marked and almost continuous with the peripheral area, at the same time the portion of each lateral rib near the umbilical margin becomes very prominent, while the rest of it gets flatter and broader.

Dimensions.

	(*a*)	(*b*)	(*c*)
Diameter of shell	152 mm. (1)	96 mm. (1)	94 mm. (1)
Height of outer whorl	66 mm. (0·43)	42 mm. (0·43)	41 mm. (0·43)
Thickness of outer whorl	73 mm. (0·48)	50 mm. (0·52)	44 mm. (0·47)
Width of umbilicus	42 mm. (0·27)	26 mm. (0·27)	27 mm. (2·28)

Observations.—The present species is founded upon the three specimens of which the dimensions are given above. The largest example, upon which the above description has been mainly based, is entirely septate and bears indications of having possessed at least another half whorl, which was probably occupied by the body-chamber. The robustness of the shell, with its prominent lateral spines and rounded periphery easily separate this species from the rest of the species in Mr. Anderson's collection. Its nearest ally appears to be the form from the Middle Utatúr Group (*Acanthoceras*-horizon) of

Southern India that Dr. Kossmat* has identified with White's *Ammonites Turneri* from the Cretaceous rocks of California,† but the Indian form is a stouter and less rapidly expanding shell, whilst the tubercles in the outer row on the lateral area are not elongated in the direction of the spiral as in the African form.

The collection also contains a completely septate specimen probably belonging to either this species or a closely-allied form. Its measurements are as follows: Diameter of shell, 94 mm. (1); height of outer whorl, 44 mm. (0·47); thickness of outer whorl, 45 mm. (0·48); and width of umbilicus, 25 mm. (0·26). From these it will be seen that the specimen, although resembling *Acanthoceras robustum*, has the outer whorl relatively higher, the umbilicus relatively narrower, the sides flatter, and at the same diameter the lateral tubercles sharper and more prominent than in that species. Notwithstanding the similarity between the two forms, further specimens may show that they are specifically distinct.

Allied also to this species, but probably distinct therefrom, is another completely septate shell having the tubercles on the periphery arranged as in the other specimens, but with the ribs slightly more flexuous; on the inner whorls these are apparently alternately long and short, but on the last half of the outer whorl they all extend across the whorl, the tubercles at the outer edge of the whorl becoming gradually stronger, whilst at the anterior end of the specimen the ribs and tubercles rather suddenly become much more distant. The whorls are subtrapezoidal in transverse section, the greatest thickness being near the umbilical margin. The dimensions of the fossil are: Diameter of shell, 95 mm. (1); height of outer whorl, 42 mm. (0·44); thickness of outer whorl, 48 mm. (0·50); and width of umbilicus, 27 mm. (0·28).

Acanthoceras, *sp.*

Observations.—Another species of *Acanthoceras* seems to be represented by a large fragment consisting of parts of two adjacent whorls. At the anterior end of the specimen the transverse section of the outer whorl is 76 mm. high and 90 mm. wide (excluding the prominent ribs), the inner whorl at the same place being 40 mm. wide and the portion of the lateral area exposed within the umbilicus 25 mm. across. The outer whorl is entirely septate, and as there are no indications on it of a succeeding whorl it probably formed a part of the outer whorl of a large specimen in close proximity to the base of the body-chamber. The outer whorl is subquadrate in transverse section; it is crossed by ribs having an almost radial direction, their umbilical portions being 24 mm. apart, very prominently rounded, and 5 or

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* F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 2 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. xi., Heft i.), 1897, p. 109 (2), Pl. xii. (i.), f. 1*a*, *b*; Pl. xiv. (iii.), f. 3.

† C. A. White, On Invertebrate Fossils from the Pacific Coast (Bull. U.S. Geol. Surv., viii., 1888–89, No. 51), 1889, p. 26 (456), Pl. v., f. 1, 2.

6 mm. wide, their outer portions obscure, but each rib is raised at its outer end into an enormous tubercle. The periphery is very much flattened, the ribs being subdivided in its median portion, and there are faint traces of other ribs in the interspaces. There is a low obscure keel along the centre of the periphery, and there is also an obscure elongated tubercle on the peripheral side of the base of each large lateral tubercle.

At first sight this fossil resembles *Acanthoceras Cunningtoni*, Sharpe, sp.,* from the Grey Chalk (Cenomanian) of England, and *A. Cunningtoni*, var. *cornuta*, Kossmat,† from the Middle Utatúr Group at Ódiam, in Southern India; but compared with those forms, the large tubercles on the outer edge of the whorl are nearer together, whilst near the umbilical margin it bears strongly-compressed prominent ribs instead of other large tubercles; further, the sculpture of its inner whorl, consisting of alternately long and short forwardly-directed ribs, at once distinguishes it.

Acanthoceras quadratum, *sp. nov.*

(Pl. XIII., Figs. 2, 2*a*.)

Description.—Shell discoidal, stout, umbilicated, with a few subangular whorls; greatest thickness near the umbilical margin, about one-half of the diameter of the shell; height of outer whorl about three-sevenths of the diameter of the shell. Whorls (? number); inclusion about two-fifths; umbilicus with broadly-rounded margin, steep convex walls almost perpendicular to the mesal plane of the shell. Length of body-chamber and aperture not seen. Chambers rather deep, about four-sevenths of the corresponding height of the whorl in depth: suture-line with ventral lobe long and narrow; external saddle deeply bipartite, its external portion narrow, its lateral portion broad and extending nearly to the middle of the lateral area; first lateral lobe on the middle of the lateral area, narrow, of about the same length as the ventral lobe, bifid; first lateral saddle broadly rounded, extending to the umbilical margin; the second lateral lobe small, long, narrow, unequally bifid, situated on the umbilical margin; second lateral saddle rather broad, bipartite, and placed on the umbilical zone. Whorl subquadrate in transverse section, rather wider than high; indented to about one-sixth of its height by the preceding whorl; periphery feebly-convex, flattened, bounded on each side by a row of obscure, longitudinally-elongated tubercles, and almost continuous with the adjacent portion of the lateral area; sides flattened, slightly convergent, not sharply defined from the umbilical zone; umbilical zone steep, convex, almost perpendicular to the mesal plane of the shell. Test ornamented with

* D. Sharpe, Foss. Moll. Chalk of England (Mon. Pal. Soc.), Pt. 2, 1854, p. 35, Pl. xv., f. 2*a*, *b*, *c*. [Specimen in Brit. Mus. Coll.; register No. 88,704.]

† F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 2 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. xi., Heft i.), 1897, p. 125 (18), Pl. xvi. (v.), f. 1*a*, *b*, *c*.

about twenty or twenty-one ribs per whorl; these in crossing the whorl pass from the umbilical area in a slightly forward direction over the umbilical margin, whence they traverse in an almost radial direction the greater part of the lateral area of the whorl, turning slightly forward shortly before reaching the margin of the periphery, and then passing nearly straight across the periphery; the portion of the rib near the umbilical margin much compressed and very prominent, raised into a transversely-elongated tubercle, but the rest of the rib broad, flattened, and on the periphery very obscure, merely a swelling; besides the umbilical tubercle each rib bears five tubercles, a longitudinally-elongated one at the centre of the periphery, becoming very obscure with the growth of the shell, a longitudinally-elongated one at each margin of the periphery, and a prominent slightly-elongated tubercle on the lateral area near the peripheral margin that increases rapidly with the growth of the shell and projects outwards nearly in a line with the periphery; in the younger stages of growth the ribs are alternately longer and shorter, the shorter ones arising at about one-third of the width of the lateral area from the umbilicus and lacking the umbilical tubercles.

Dimensions.

Diameter of shell	111 mm.	(1)
Height of outer whorl	47 mm.	(0·42)
Thickness of outer whorl (excl. ribs)	55 mm.	(0·49)
Width of umbilicus	33 mm.	(0·29)

Observations.—This species is represented in Mr. Anderson's collection by a fairly well preserved completely septate internal cast, of which the dimensions are given above; and a septate fragment of a little larger shell consisting of about one-fourth of the outer whorl and the adjacent portion of the next inner whorl. The internal cast on which the above description is principally based comes very near the example of *Ammonites sussexiensis* in the British Museum collection [register number 5691], that is marked as the original of Mantell's "Fossils of the South Downs," Pl. xx., f. 2.* The specimen bears the Mantellian label, "XX. 2," indicating that it is the figured specimen, otherwise it would be almost impossible to recognise it from Mantell's figure. It is much more finely ornamented than the figure represents. At the greatest diameter at which its dimensions can be taken, these are: Diameter of shell, 147 mm. (1), excluding the raised rib on the periphery; height of outer whorl, 57 mm. (0·38), also excluding the peripheral rib; thickness of outer whorl, 59 mm. (0·40), excluding the rib; and width of umbilicus, 52 mm. (0·35). At the diameter of the African example, viz., 111 mm., the other dimensions of Mantell's specimen are: Height of outer whorl, 47 mm. (0·42), excluding the raised rib on the periphery; thickness of outer whorl,

* D. Sharpe (Foss. Moll. Chalk—Mon. Pal. Soc.—Pt. 2, 1854, p. 34), regards this specimen as the type of *Ammonites sussexiensis*, and the other specimen, figured by Mantell (Pl. xxi., f. 10) under this name, as *Ammonites rotomagensis*.

52 mm. (0·47), excluding the ribs; and width of umbilicus, 33 mm. (0·29). Compared then with the English specimen, the African form has relatively slightly thicker whorls, and is rather more coarsely ornamented, having in its outer whorl about twenty or twenty-one ribs, whereas the English specimen has about twenty-five ribs in a whorl of about the same diameter; but the peripheral portion of the ribs in the African form is perceptible in the adult merely as a swelling, whereas in *Acanthoceras sussexiense* it constitutes a thick raised rib, continuous with the ribs on each side of the whorl. The aspect of the periphery in the adult more nearly resembles that of *Acanthoceras latum* described below,* but that species is a more coarsely ornamented and a more rapidly increasing shell. Neither Mantell's specimen nor the African form exhibits any subdivision either of the peripheral portion of its ribs or of the tubercles along the centre of the periphery, characters which Sharpe attributes to *Acanthoceras sussexiense.* In fact, the African fossil resembles *Acanthoceras rotomagense* more closely than *Acanthoceras sussexiense* as interpreted by Sharpe.†

ACANTHOCERAS HIPPOCASTANUM, *J. de C. Sowerby, sp.*
(Pl. XIII., Figs. 4, 4*a*.).

1826. *Ammonites hippocastanum*, J. de C. Sowerby, Min. Conch., vi., p. 24, Pl. dxiv., f. 2.
1856. *Ammonites hippocastanum*, D. Sharpe, Foss. Moll. Chalk of England (Mon. Pal. Soc.), Pt. 3, p. 37, Pl. xvii., f. 2, 3, 4.

Observations.—This species is represented in Mr. Anderson's collection by a moderately well-preserved fossil having the following dimensions: Diameter of shell, 35 mm. (1); height of outer whorl, 16·5 mm. (0·47); greatest thickness of outer whorl, 20 mm. (0·57); width of umbilicus, 8·5 mm. (0·24). The measurements of the species as given by Sharpe are: Diameter, 2½ inches (1); height of last whorl, 1¼ inch (0·5); width of aperture [*i.e.*, thickness of whorl], 1½ inch (0·6). Practically these are relatively the same as in the African form. The younger portion of the outer whorl of the African specimen almost exactly agrees with the specimen figured by Sharpe, *op. cit.*, Pl. xvii., f. 3*a*, 3*b*, from the Lower Chalk (Cenomanian) of Chardstock, Dorset. Sowerby's type-specimen came from the Lower Chalk (Cenomanian) of Dowlands, Devonshire, and Sharpe records the species as "tolerably common in the Chalk with siliceous" "grains [Cenomanian] of Lyme Regis, Dorsetshire, and Chardstock," "Somersetshire [Dorset]." When describing *Ammonites rotomagensis*, Sowerby stated that his *Ammonites hippocastanum* "may possibly be only a" "remarkable variety of it."‡ Whilst some Continental authors have

* See *postea*, p. 195.
† D. Sharpe, Foss. Moll. Chalk of England (Mon. Pal. Soc.), Pt. 2, 1854, pp. 34 and 35, Pl. xv., f. 1*a*, *b*, *c*, *d*.
‡ J. de C. Sowerby, Min. Conch., 1826, vi., p. 26.

regarded the form as a variety of *rotomagensis*, Sharpe * and Stoliczka † acknowledge the validity of the species, the former considering it to have more affinity to his *Ammonites Cunningtoni* than to *Ammonites rotomagensis*, an opinion, however, which, as has already been pointed out by Pictet, ‡ is not supported by a comparison of the development of the ornaments in *Acanthoceras hippocastanum* or *Acanth. rotomagense* with their development in *Acanth. Cunningtoni*. Stoliczka does not record the species from the Cretaceous rocks of India.

Acanthoceras latum, *sp. nov.*

(Pl. XII., Figs. 2, 2*a*.)

Description.—Shell composed of a few rapidly increasing angular whorls, umbilicated; greatest thickness (excluding the spines) at about the middle of the lateral area, rather more than one-half of the diameter of the shell; height of outer whorl a little more than two-fifths of the diameter of the shell. Whorls few, about 5 or 6; inclusion about one-fourth in the adult, but greater in the young; umbilicus deep, with steep, convex walls, about two-sevenths of the diameter of the shell in width. Whorl subquadrangular in cross-section, wider than high; only slightly impressed by the preceding whorl; periphery feebly convex, broad, flattened, with spinose margins; sides somewhat flattened; umbilical zone broad, steep, convex. Body-chamber consisting of, at least, about one-half of a whorl; aperture not seen. Depth of chambers (?); suture-line imperfectly known. Test: in the young stages of growth ornamented with obscure flattened ribs which bifurcate from a transversely-compressed tubercle on the umbilical margin; at a later stage with alternately longer and shorter flattened ribs, each of the former arising on the umbilical zone of the whorl and passing slightly forward on to and over the lateral area, being raised at a short distance from the umbilical margin into a prominent transversely-compressed tubercle, and then becoming broader and flatter, passing over the periphery with a broad orad-convex curve, bearing a compressed tubercle at the middle of the periphery, and two larger compressed tubercles on each side, whilst each of the shorter ribs arising at the umbilical margin without any tubercle broadens in crossing the lateral area, and passes over the periphery parallel to, and similarly ornamented to, each longer rib; with age the smaller intermediate ribs gradually disappear, every rib arises on the umbilical zone of the whorl, its umbilical portion remains very prominent, whilst its lateral and peripheral portions become much broader and more obscure, the transversely-compressed tubercles near the umbilical margin become much more prominent, the longitudinally-elongated tubercles § at the edge of the lateral area greatly

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* D. Sharpe, Foss. Moll. Chalk of England (Mon. Pal. Soc.), 1856, Pt. 3, p. 38.
† F. Stoliczka, Cret. Fauna S. India (Pal. Indica), i., Cephalopoda, p. 70.
‡ F. J. Pictet, Mélanges paléontologiques, 1863, i., 1re livr., pp. 32, 33.
§ As shown by the earlier stages of growth these tubercles are on the lateral area.

increased, whilst the median row of tubercles on the periphery coalesce and form an almost continuous keel, the nodes * in the row on each side at the same time lengthening and becoming much less prominent.

Dimensions.

Diameter of shell	... ...	109 mm. (1)
Height of outer whorl (excl. spines)	...	48 mm. (0·45)
Thickness of outer whorl (,,)	...	58 mm. (0·53)
Width of umbilicus	... ...	31 mm. (0·28)

Observations.—The type of this species is the specimen of which the dimensions are given above. It is in a fair state of preservation, and consists of the septate part of the shell up to a diameter of 109 mm. A portion of the attached dorsal surface of a continuation of the whorl for a little more than half a turn exhibits on its outer surface marks of septa for a length of only about 40 mm., so that the rest of this attached surface, extending for nearly another half whorl, belonged to the body-chamber.

Another specimen in Mr. Anderson's collection, apparently belonging to this species, consists of the half of the internal whorls of a shell up to a diameter of 46 mm. (1). At this diameter the whorl is subquadrangular in cross-section, 21 mm. (0·45) high, 25 mm. (0·54) wide—the greatest thickness being here close to the umbilical margin—and the umbilicus 12 mm. (0·26) wide. The fractured surface also shows that at a diameter of 31 mm. (1) the whorl is also subquadrangular in cross-section, 14 mm. (0·45) high, 17 mm. (0·55) wide, but the width of the umbilicus is not shown. A comparison of the sculpture of the lateral area of this fragment with that of the inner whorl of the more nearly complete example leads me to refer both to the same species.

The young of this species appears to be represented in the same collection by a shell having the following measurements: Diameter of shell, 19 mm. (1); height of outer whorl, 9 mm. (0·47); thickness of outer whorl, 11·5 mm. (0·60); width of umbilicus, 4 mm. (0·21). At this diameter the shell somewhat resembles the young of the form that is here referred to *Acanthoceras hippocastanum*, but it is thicker and less coarsely ornamented than that species.

At first sight *Acanthoceras latum* seems to belong to the group of *Acanthoceras Cunningtoni*, and to be allied to such forms as *Acanthoceras Cunningtoni*, Sharpe, sp.,† and *Acanthoceras sussexiense*, Mantell, sp.,‡ from the Lower Chalk (Cenomanian) of England,

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* The earlier stages of growth show that these nodes indicate the margin of the periphery.

† D. Sharpe, Foss. Moll. Chalk S. of England (Mon. Pal. Soc.), Pt. 2, 1854, p. 35, Pl. xv., f. 2*a*, *b*, *c*.

‡ G. A. Mantell, Foss. S. Downs, 1822, p. 114, Pl. xx., f. 2 (not Pl. xxi., f. 10). See also D. Sharpe, Foss. Moll. Chalk S. of England (Mon. Pal. Soc.), Pt. 2, 1854, p. 34, Pl. xv., f. 1*a*, *b*, *c*, *d*.

and to *Acanthoceras Cunningtoni*, var. *cornuta*, Kossmat, * and *Acanthoceras meridionale*, Stoliczka, sp., † from the Utatúr Group of Southern India, but the sculpture of the periphery of the earlier whorls, especially the undivided ribs between the marginal nodes of this area, at once separate this species therefrom. This species seems rather to belong to the group of *Acanthoceras rotomagense*, and to be allied rather to such a form as Kossmat ‡ has identified as *Acanthoceras Turneri*, White, sp.,§ from the Middle Utatúr Group of Odiam, in the Trichinopoli district of Southern India, but the more rapidly-expanding shell and the coarser ornaments of the present species easily distinguish it from that form.

ACANTHOCERAS NEWBOLDI, *F. Kossmat.*

1897. *Acanthoceras Newboldi*, F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 2 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. xi., Heft 1), p. 111 (4).

Excluding three large fragments, of which we refer one to the typical form and the others to the var. *planicostata*, the forms in Mr. Anderson's collection that we identify with this species can be grouped into two sets of three specimens each; one set is here referred to the typical form, whilst the other, including somewhat more inflated shells, appears to represent Kossmat's var. *spinosa*. Besides a fragment which is closely related to, if not identical with, Kossmat's var. *spinosa*, the collection includes three other examples which we think should be referred to a distinct, though closely allied, species, for which the name *nitidum* is here proposed.

(*a*) ACANTHOCERAS NEWBOLDI (*typical form*), *F. Kossmat.*

1865. *Ammonites Rhotomagensis* (*pars*), F. Stoliczka, Cret. Fauna S. India (Pal. Indica), i., Cephalopoda, p. 66, Pl. xxxiv., f. 3, 3*a*, 4, 4*a*, 4*b*; Pl. xxxv., f. 1, 1*a*; Pl. xxxvi., f. 1; Pl. xxxvii., f. 1, 2.

1894. *Acanthoceras Rhotomagense*, var. *asiatica*, K. Jimbo, Beiträge zur Kenntnis der Fauna der Kreideformation von Hokkaido (Paläontologische Abhandlungen, Dames and Kayser, Bd. vi., Heft 3), p. 31 (177), Pl. iv. (xx.), f. 1, 1*a*.

1895. *Acanthoceras Rotomagense*, M. Boule, Note sur les fossiles rapportées de Madagascar par M. E. Gautier: Bull. Mus. d'hist. nat. Paris, i., 1895, No. 5, p. 184.

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* F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 2 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. xi., Heft 1), 1897, p. 125 (18), Pl. xvi. (v.), f. 1*a*, *b*, *c*.

† F. Stoliczka, Cret. Ceph. S. India (Pal. Indica), p. 76, Pl. xli., f. 1, 1*a*, 1*b*, 1*c*.

‡ F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 2 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. xi., Heft 1), 1897, p. 109 (2), Pl. xii. (i.), f. 1*a*, *b*; Pl. xiv. (iii.), f. 3.

§ C. A. White, On Invertebrate Fossils from the Pacific Coast (Bull. U.S. Geol. Surv., viii., 1888–89, No. 51), 1889, p. 26 (456), Pl. v.

1897. *Acanthoceras Newboldi* (*typical form*), F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 2 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. xi., Heft i.), p. 112 (5), Pl. xii. (i.), f. 2*a*, *b*, 3*a*, *b*, *c*; Pl. xiv. (iii.), f. 2.

1902. *Ammonites* (*Acanthoceras*) *rhotomagensis*, M. Boule, in Madagascar au début du xx^{e} siècle, by R. Blanchard and others, p. 52, f. 36.

1906. *Acanthoceras* [*Douvilleiceras*] *Newboldi*, P. Lemoine, Études géol. nord de Madagascar, p. 205.

Observations.—Excluding a badly-preserved fragment of a large example the typical form of the species seems to be represented by three specimens having the following dimensions:—

	(*a*)	(*b*)	(*c*)
Diameter of shell...	57 mm. (1)	44·0 mm. (1)	22 mm. (1)
Height of outer whorl ...	25 mm. (0·44)	19·5 mm. (0·44)	10 mm. (0·45)
Thickness of outer whorl ...	27 mm. (0·47)	22·0 mm. (0·50)	11 mm. (0·50)
Width of umbilicus	16 mm. (0·28)	12·5 mm. (0·28)	6 mm. (0·27)

These relative dimensions agree very well with those given by Dr. Kossmat. The largest example is completely septate, and the row of nodes on the lateral area next the row at the margin of the periphery is visible, though somewhat obscure, even at the anterior end of the specimen. As an example of the typical form of this species Dr. Kossmat mentions a specimen in the British Museum (Natural History) from the Cenomanian of Chard, Somerset, bearing the register number 37574. This specimen has the following measurements: Diameter of shell, 42·5 mm. (1); height of outer whorl, 18·5 mm. (0·43); thickness of outer whorl, 25 mm. (0·59); width of umbilicus, 13·5 mm. (0·31). Nearly the last half of the outer whorl is occupied by the body-chamber; the tubercles on the lateral area next the row of tubercles on the margin of the periphery, that on the earlier part of the whorl are much more strongly developed on some of the ribs, chiefly the longer ones, than on the others, suddenly disappear at about the commencement of the body-chamber, but the tubercles at the margin of the periphery, and obscure traces of the siphonal row of tubercles, are present at the anterior end of the shell. The relative measurements of the specimen agree very closely with those of the examples given by Dr. Kossmat of his var. *spinosa*, and also with those of the specimens referred in this paper to the same variety.

The fragment in Mr. Anderson's collection that is here identified with the typical form of Dr. Kossmat's species is a very imperfect internal cast in calcite; it is entirely septate and consists of about one-third of a whorl, the transverse section of which at about the middle is 62 mm. high and 69 mm. wide. The row of tubercles adjacent to

the row at the margin of the periphery can be traced to the anterior end of the specimen. Although belonging to an Ammonite of considerable size, larger examples of the same species have been recorded from Southern India, whence Kossmat quotes an example 220 mm. in diameter, the transverse section of the whorl at the anterior end being 81 mm. high and 90 mm. wide.

The three other examples referred to this form are entirely septate; in the largest specimen (57 mm. in diameter) the row of tubercles adjacent to the row bordering the peripheral area is still conspicuous at the anterior end of the specimen, but the siphonal row has almost disappeared. The medium-sized specimen agrees very well with Dr. Kossmat's Pl. xii., f. 3*a*, *b*.

At first sight these specimens appear to closely resemble *Acanthoceras Choffati*, * but that species has finer ribbing, its ribs are feebly sigmoidal, and in passing from the umbilical margin to the periphery are more forwardly-inclined.

Dr. Kossmat records the typical form of *Acanthoceras Newboldi* from the Middle Utatúr Group (*Acanthoceras* horizon) of Southern India. He also identifies it from the Middle Cenomanian of Chard, Somerset, † and considers that the specimen figured by Sharpe as *Ammonites rhotomagensis* from the Grey Chalk of Bonchurch, Isle of Wight (Pl. xvi., f. 2*a*, *b*), belongs to this type, being a form intermediate between *Acanth. Newboldi* and *Acanth. Newboldi*, var. *spinosa*, with a greater affinity to the former. Under the name *Acanthoceras rotomagense* a similar form has been recorded by M. Boule ‡ from the Cenomanian in the southern part of Madagascar, whilst P. Lemoine § has recorded *Acanth. Newboldi* from the extreme north of the island. Kossmat considers that the *Acanthoceras rhotomagense* var. *asiatica* of Jimbo, from the Upper Cretaceous of Japan, most probably belongs here. The species occurs also in Syria. ||

(*b*) Acanthoceras Newboldi, var. spinosa, *F. Kossmat.*

(Pl. XII., Figs. 3, 3*a*.)

1865. *Ammonites Rhotomagensis* (var. *inflatus*), F. Stoliczka, Cret. Fauna S. India (Pal. Ind.), i., Ceph., p. 68, Pl. xxxv., f. 2, 2*a*, 2*b*.

1897. *Acanthoceras Newboldi*, var. *spinosa*, F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 2 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. xi., Heft 1), p. 114 (7), Pl. xiii. (ii.), f. 2*a*, *b*, *c*, 3*a*, *b*; Pl. xiv. (iii.), f. 1*a*, *b*.

1906. *Acanthoceras* [*Douvilleiceras*] *Newboldi*, var. *spinosa*, P. Lemoine, Études géol. nord de Madagascar, p. 205.

Observations.—According to Dr. Kossmat, this form must have attained considerable dimensions, for he records a fragment of a

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* See *postea*, p. 205.

† F. Kossmat, *op. cit.*, p. 113 (6).

‡ M. Boule, Bull. Mus. d'hist. nat. Paris, i., 1895, No. 5, p. 184. M. Boule, in Madagascar au début du xx^e^ siècle, by R. Blanchard and others, 1902, p. 52, f. 36.

§ P. Lemoine, Études géologiques dans le nord de Madagascar, 1906, p. 205.

|| M. Blanckenhorn, Zeitschr. Deutsch. geol. Gesell., lii., 1900, p. 42.

whorl, of which the transverse section is 67 mm. high and 85 mm. wide. The measurements, however, given by that author are those of specimens 71, 93 and 99 mm. in diameter respectively, the two latter being regarded as medium-sized. The three specimens in Mr. Anderson's collection that we refer to this variety of *Acanth. Newboldi* have the following dimensions :—

	(*a*)	(*b*)	(*c*)
Diameter of shell...	51 mm. (1)	42·5 mm. (1)	24·5 mm. (1)
Height of outer whorl ...	22 mm. (0·43)	19·0 mm. (0·45)	11·5 mm. (0·47)
Thickness of outer whorl ...	28 mm. (0·55)	25·0 mm. (0·59)	14·0 mm. (0·57)
Width of umbilicus	15 mm. (0·29)	12·5 mm. (0·29)	7·0 mm. (0·28)

If rightly determined, then, these are all small examples; each is completely septate; the largest and the medium-sized specimen have each traces of another half-whorl, which, since there are traces of septa only near its commencement, appears to have been occupied by the body-chamber. The largest specimen (Pl. XII., Figs. 3, 3*a*) is a little asymmetrical, the asymmetry, added to the slight breaking away of the umbilical zone of the last half whorl, causing the tubercles on the umbilical margin to slightly overhang the umbilicus; the tubercles in the second row (counting from the umbilicus) are fairly uniform in size and quite distinct at the anterior end of the specimen, but the siphonal row is represented by only a feeble swelling of the rib at the middle of the periphery. In the medium-sized example, the tubercles in the second row are not quite of a uniform size, those on the principal ribs being larger than the rest; they become very obscure at the anterior part of the specimen. Here also the siphonal row of tubercles is almost obsolete. The greater prominence of the ribs, the greater development of the tubercles on the umbilical margin and on the lateral area, as well as the relatively greater width of the transverse section of the whorl, distinguish this variety from the typical form of the species.

This variety occurs in the Middle Utatúr Group (*Acanthoceras* horizon) in Southern India, being plentiful in the brown sandstone at Odiam; and probably also, according to Dr. Kossmat (*op. cit.*, p. 115), in the Cenomanian of Europe. It has been recorded * from the north of Madagascar.

The collection also includes a fragment, consisting of nearly half of a whorl 45 mm. in diameter, which seems to be closely allied to the present variety of *Acanth. Newboldi*, or to be a form intermediate between this variety and the form described below as *Acanthoceras nitidum.*† The tubercles on the lateral area are nearer the tubercles on the umbilical margin than in this variety, and as seen in the umbilicus they were not in contact with the suture of the shell.

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* P. Lemoine, Études géologiques dans le nord de Madagascar, 1906, p. 205.

† See *postea*, p. 201.

(*c*) ACANTHOCERAS NEWBOLDI, var. PLANICOSTATA, *F. Kossmat.*

1897. *Acanthoceras Newboldi*, var. *planecostata*, F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 2 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. xi., Heft i.), p. 116 (9), Pl. xiii. (ii.), f. 1*a*, *b*, *c*.

Observations.—To this variety are referred a couple of large, completely septate, fragments about 150 mm. and 180 mm. long (measured along the periphery) respectively. The smaller one, the better preserved of the two, has a trapezoidal transverse section—at the anterior end 61 mm. high and 70 mm. wide—and its sculpture agrees very well with that of Dr. Kossmat's figured example, the broadly rounded ribs being about 7 mm. wide at the middle of the periphery. Dr. Kossmat knew this variety only from the Middle Utatúr Group (*Acanthoceras*-horizon) at Odiam, in Southern India.

ACANTHOCERAS LATICOSTATUM, *sp. nov.*

The collection contains also a fragment—about 150 mm. long—of a large whorl with a subtrapezoidal cross-section about 78 mm. high and 85 mm. wide. As in *Acanthoceras Newboldi*, var. *planicostata*, it is crossed by alternately longer and shorter ribs, which are broadly flattened on the periphery, being on the median part of the periphery about 11 or 12 mm. wide and 7 or 8 mm. apart. Each rib bears at the margin of the periphery—here about 35 mm. wide—a longitudinally-elongated obtuse tubercle, and on the lateral area, at about 21 mm. from the tubercle on the peripheral margin, another similarly elongated, but rather more prominent, tubercle. The posterior end is bounded by a septal surface, and the fragment appears to be the posterior part of the body-chamber of a large specimen. Though closely allied to *Acanthoceras Newboldi*, var. *planicostata*, it seems to be quite distinct therefrom; although very imperfect it nevertheless seems desirable, for convenience of reference, to name the specimen; the name *laticostatum* is therefore suggested for it.

ACANTHOCERAS NITIDUM, *sp. nov.*

(Pl. XII., Figs. 4, 4*a*.)

Description.—Shell discoidal, umbilicated, with a few inflated whorls; greatest thickness at about three-sevenths of the width of the lateral area from the suture, about four-sevenths of the diameter of the shell; height of outer whorl about three-sevenths of the diameter of the shell. Whorls few (? exact number); inclusion about one-half; umbilicus rather deep, with rounded margin and convex sides, about three-elevenths of the diameter in width. Whorl trapezoidal in transverse section, wider than high; indented to about one-sixth of its height by the preceding whorl; periphery convex and continuous with the sides, its margins indicated by a row of tubercles on each side; sides evenly convex, passing insensibly into the umbilical zone; umbilical

zone convex, steep, not sharply defined from the lateral area. Body-chamber apparently occupying fully half a whorl; aperture not seen. Chambers not very deep; suture-line imperfectly known, only septal surface imperfectly seen. Test with alternately long and short ribs; the longer ribs arise at the suture of the shell, pass slightly forwards in crossing over the umbilical zone of the whorl as far as the umbilical margin, whence they pass uninterruptedly in an almost radial direction across the whorl; the shorter intermediate ribs arise at about the centre of the lateral area, or a little nearer the umbilical margin as the shell advances in growth, and pass uninterruptedly in an almost radial direction across the whorl; each rib bears a small longitudinally-elongated tubercle at the margin of the periphery, the longer ribs bearing a tubercle also at the umbilical margin. In the young shell two shorter ribs are generally interpolated between each pair of longer ones, all the tubercles are more pronounced, in fact, may perhaps be better characterised as spines, each rib bearing in addition to the spine at the peripheral margin another on the lateral area, whilst the umbilical spines of the longer ribs are relatively greater than in the adult; further, in the middle of the periphery there is a row of small tubercles, which gradually disappear by the time the shell has attained a diameter of about 20 mm. The lateral spines become obsolete at a diameter of about 28 mm.

Dimensions.

	(*a*)	(*b*)
Diameter of shell ...	... 37 mm. (1)	18 mm. (1)
Height of outer whorl ...	... 17 mm. (0·46)	8 mm. (0·44)
Thickness of outer whorl	... 21 mm. (0·57)	11 mm. (0·61)
Width of umbilicus ...	... 10 mm. (0·27)	4 mm. (0·22)

A fragment consisting of about one-fourth of a whorl, estimated at about 50 mm. (1) in diameter, measures at its anterior end 23 mm. (0·46) in height and 30 mm. (0·60) in width.

Observations.—To this species are referred the two specimens and the fragment of which the dimensions are given above. Each example is entirely septate; the medium-sized specimen (*a*, Pl. XII., Figs. 4, 4*a*) is regarded as the type, although being incomplete it does not perhaps exhibit all the characters of the adult shell. The small shell is relatively slightly thicker than the type, but otherwise seems to agree with the earlier whorls of that specimen.

Of the specimens in Mr. Anderson's collection the present species approximates very closely the forms here referred to *Acanthoceras Newboldi* and its variety *spinosa*, but from these it can be distinguished by the greater convexity of the lateral area and of the periphery of its whorls, by the much earlier disappearance of the row of tubercles on its lateral area, and by the much smaller size of the tubercles on its umbilical margin. The fragment somewhat resembles the specimen here described as *Acanthoceras* aff. *Choffati*,* but in that example the

* See *postea*, p. 207.

whorl has a relatively wider transverse section, whilst the ribs form a slight but distinct sigmoidal curve on the lateral area.

Acanthoceras nitidum bears a striking resemblance to the specimen * from the Chalk Marl of Hamsey, Sussex, figured as *Ammonites Mantelli* by Mantell in his "Fossils of the South Downs, &c.," 1822, Pl. xxi., f. 9, but compared with that fossil its whorls are somewhat more tumid, its row of umbilical tubercles more prominent, whilst the ribs in passing from the suture across the umbilical zone of the whorl have a forward direction instead of a backward direction as in Mantell's specimen.

Acanthoceras paucinodatum, *sp. nov.*

(Pl. XIII., Figs. 3, 3*a*.)

(*Cf. Ammonites navicularis*, D. Sharpe, Foss. Moll. Chalk of England (Mon. Pal. Soc.), Pt. iii., 1856, Pl. xviii., f. 3 only.)

Description. — Shell inflated, umbilicated, composed of a few rounded or subquadrangular and not very rapidly increasing whorls; greatest thickness at a short distance from the umbilical margin, nearly one half of the diameter of the shell; height of outer whorl about two-fifths of the diameter of the shell. Whorls few (? exact number); inclusion nearly one half; umbilicus with steep, almost perpendicular walls, nearly one-third of the diameter of the shell in width. Whorl subquadrate in transverse section, a little wider than high; very slightly impressed by the preceding whorl; periphery broadly convex, and imperfectly defined in the ephebic stage, but in the neanic stage defined by a row of obscure tubercles on each side; sides feebly convex, rather flattened, not clearly marked off from the periphery; umbilical zone well defined, almost perpendicular to the mesal plane of the shell. Body-chamber occupying at least, and probably more than, one-third of the outer whorl; aperture not seen. Chambers about one half of the corresponding height of the whorl deep; suture-line imperfectly known. Test ornamented with prominent rounded ribs, about thirty-six or thirty-seven on the outer whorl; these are alternately longer and shorter; the longer ribs arise from near the suture of the shell, and in passing up the umbilical wall rapidly increase in strength and form a prominent compressed tubercle on the umbilical margin; thence they pass in a nearly radial direction across about two-thirds of the lateral area, and then, bending slightly forward, pass on to the periphery, which they cross without interruption in a feeble forwardly-convex curve; some of the longer ribs are more prominent than the others and appear to have borne a blunt compressed tubercle at about the middle of the

* Now in British Museum collection, register number C. 5028. Mantell's figure makes the ribbing appear too coarse and the tubercles at each margin of the periphery much too large and transversely, instead of longitudinally, elongated, *i.e.*, they are represented as being elongated in the direction of the length of the rib instead of in the direction of the length of the whorl.

lateral area; the shorter ribs originate at a point about one-third of the width of the lateral area from the umbilical margin, and traverse the whorls in a direction quite similar to that of the longer ribs; at the point where the ribs bend forward on the lateral area, each rib on the earliest part of the outer whorl is feebly tuberculated and bears also a feeble tubercle on each side of the periphery, but these tubercles gradually become mere angularities of the ribs and finally disappear on the body-chamber; the ribs appear not to have had a median peripheral tubercle even on the earliest part of the outer whorl.

Dimensions.

Diameter of shell	...	...	65 mm. (1)
Height of outer whorl	...	...	27 mm. (0·41)
Thickness of outer whorl	...	...	30 mm. (0·46)
Width of umbilicus	...	...	20 mm. (0·30)

Observations.—This species is represented in Mr. Anderson's collection by a single moderately well preserved specimen, having the dimensions given above; on one side the specimen is a little weathered and displays the worn-down edges of several septa; one-third of the outer whorl is occupied by the body-chamber. As to the affinities of the fossil there can be no possible doubt, although unfortunately the suture-line of the specimen is only imperfectly shown. It is clearly allied to the group of forms which Sharpe * has referred to *Ammonites navicularis*, and especially to the original† of his f. 3, which has the following dimensions: Diameter, 66 mm. (1); height of outer whorl, 29 mm. (0·44); thickness of outer whorl, 32 mm. (0·48); width of umbilicus, 18 mm. (0·27); the outer whorl bearing thirty-nine ribs. Compared therefore with Sharpe's figured specimen, the African example is a rather stouter shell, with a slightly wider umbilicus, a little coarser ornamentation, and a greater inequality in the strength of some of the longer ribs. Whether Sharpe's specimens are correctly referred to Mantell's species, and also whether they all belong to one and the same species, there is some reason to doubt. Pictet‡ regards the specimen subsequently figured by Sowerby § as *Ammonites navicularis*, and all the specimens figured under the same name by Sharpe as belonging to Brongniart's *Ammonites Gentoni.*|| Compared with Pictet's interpretation of the last-mentioned species, the African fossil has a little narrower umbilicus and not quite so straight nor so widely separated ribs, but as to the affinity of the two species there can be no doubt. They are certainly closely allied, and the discovery

* D. Sharpe, Foss. Moll. Chalk of England (Mon. Pal. Soc.), Pt. iii., 1856, p. 39, Pl. xviii, f. 1–3, 5, and 8.

† Specimen in British Museum (Nat. Hist.), register number 50287.

‡ F. J. Pictet, Mélanges paléontologiques, i., 1e livr., 1863, pp. 33–36, Pl. vi. See also F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 2 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. xi., Heft 1), 1897, p. 118 (11).

§ J. de C. Sowerby, Min. Conch., vi., p. 105, 1827, Pl. dlv., f. 2.

|| A. Brongniart, in G. Cuvier, Recherches sur les ossemens fossiles, 4me édition, iv., 1834, p. 150; Atlas, ii., 1836, Pl. N, f. 6 A, B.

of other specimens may show that the species are identical. The African form does not agree with the broad-whorled and coarsely-ribbed species recorded from the Utatúr Group of Southern India by Stoliczka* and by Kossmat,† and referred by them to Mantell's species, *Ammonites navicularis.*

Acanthoceras Gentoni‡ characterises the Cenomanian and usually accompanies *Acanthoceras rotomagense* in the upper part of this stage, whilst the example figured by Sharpe as *Ammonites navicularis*, to which the African specimen bears a very close resemblance, is from the Lower Chalk (Cenomanian) of Chardstock,§ Dorset. Lemoine || has recorded *Acanthoceras* [*Douvilleiceras*] *navicularis*, Mantell, from the north of Madagascar.

In Eastman's translation of Professor Zittel's "Text-book of" "Palaeontology," i., 1900, Professor Hyatt proposed (p. 589) the genus *Calycoceras*, selecting as the genotype *Ammonites navicularis*, Sharpe. It is therefore highly probable that the present species should be referred to that genus, but in the absence of a diagnosis of the genus, and the fact that all the specimens figured by Sharpe may not belong to the same species, it has been thought advisable for the purpose of the present paper not to use the genus *Calycoceras*, but to retain the species, at least provisionally, in the genus *Acanthoceras.*

Acanthoceras Choffati, *F. Kossmat.*

(Pl. XII., Figs. 5, 5*a*.)

1897. *Acanthoceras Choffati*, F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 2 (Beitr. zur. Paläont. u. Geol. Österr.-Ungarns, &c., Bd. xi., Heft 1), p. 119 (12), Pl. xv. (iv.), f. 1*a*, *b*, *c*.

Observations.—Dr. Kossmat founded this species upon a unique example from the brownish sandstone (Middle Utatúr Group) at Odiam, in Southern India. Its measurements were: Diameter, 77 mm. (1); height of outer whorl, 36 mm. (0·47); thickness of outer whorl, 33 mm. (0·43); width of umbilicus, 18 mm. (0·23). To this species I refer a series of specimens in Mr. Anderson's collection ranging from 14 mm. to about 60 mm. in diameter. As will be seen by the accompanying table of measurements, the specimens exhibit differences in their relative thickness, and in the width of the umbilicus; but on the whole agree fairly well with Dr. Kossmat's type. In the largest specimen (*a*) the width of the umbilicus differs on the two sides.

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* F. Stoliczka, Cret. Fauna S. India (Pal. Indica), i., Cephalopoda, p. 73, 1864, Pl. xxxix., f. 2–4.

† F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 2 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. xi., Heft 1), 1897, p. 118 (11).

‡ The type-specimen came from the Cenomanian (Rotomagian) of Rouen.

§ For list of fossils from Chardstock, see A. J. Jukes-Browne and W. Hill, Mem. Geol. Survey United Kingdom, The Cretaceous Rocks of Britain, ii., The Lower and Middle Chalk of England, 1903, pp. 122–3.

|| P. Lemoine, Etudes géologiques dans le nord de Madagascar, 1906, p. 205.

The smallest specimen (*m*) is more finely sculptured than the corresponding portion of the next larger specimen (*l*).

	(*a*)	(*b*)	(*c*)	(*d*)	(*e*)
Diameter ...	60 mm. (1)	57 mm. (1)	54 mm. (1)	48 mm. (1)	49 mm. (1)
Height of outer whorl	26 mm. (0·43)	27 mm. (0·47)	26 mm. (0·48)	21 mm. (0·44)	23 mm. (0·47)
Thickness of outer whorl	27 mm. (0·45)	27 mm. (0·47)	27 mm. (0·50)	22 mm. (0·46)	22 mm. (0·45)
Width of umbilicus...	17* mm.(0·28)	13 mm. (0·23)	14 mm. (0·26)	13 mm. (0·27)	13 mm. (0·26)

	(*f*)	(*g*	(*h*)	(*i*)	(*j*)
Diameter ...	52 mm. (1)	49 mm. (1)	52 mm. (1)	45 mm. (1)	31 mm. (1)
Height of outer whorl	26 mm. (0·50)	22 mm. (0·45)	23 mm. (0·44)	21 mm. (0·46)	14 mm. (0·45)
Thickness of outer whorl	28 mm. (0·54)	23 mm. (0·47)	23 mm. (0·44)	20 mm. (0·44)	16 mm. (0·51)
Width of umbilicus...	13 mm. (0·25)	14 mm. (0·28)	13 mm. (0·25)	12 mm. (0·26)	7 mm. (0·22)

	(*k*)	(*l*)	(*m*)
Diameter ...	27 mm. (1)	21 mm. (1)	14·0 mm. (1)
Height of outer whorl	13 mm. (0·48)	10 mm. (0·47)	7·0 mm. (0·50)
Thickness of outer whorl	13 mm. (0·48)	11 mm. (0·52)	7·0 mm. (0·50)
Width of umbilicus...	7 mm. (0·26)	5 mm. (0·24)	3·5 mm. (0·25)

Dr. Kossmat described the species as having relatively rapidly increasing whorls, the transverse section of which was higher than wide. From the above table of measurements it will be seen that in the African specimens referred to this species the transverse section of the whorls is only rarely higher than wide, the reverse being usually the case. In these specimens the siphonal row of tubercles gradually disappears at a diameter of about 45 mm., whilst the row occupying each margin of the periphery is very pronounced up to the greatest diameter of the largest specimen (*a*); in one specimen (*h*), however, the marginal tubercles disappear at about a diameter of 50 mm., but this may be due to an injury which the shell sustained at a diameter of about 40 mm. According to Kossmat, in *Acanthoceras Choffati* the marginal tubercles gradually disappear on the body-chamber; but this chamber is not preserved in any of the examples from Zululand.

The species has hitherto been found only in Southern India, where it occurs in the Middle Utatúr Group, although Choffat† records *Acanthoceras sp. aff. Ac. Choffati* from the Upper Cretaceous rocks of

* This measurement is taken on the (anatomically) left side of the shell; on the opposite side the umbilicus is only 16 mm. wide.

† P. Choffat, Contributions à la connaissance géologique des colonies portugaises d'Afrique, i., Le Crétacique de Conducia, 1903, p. 28, Pl. viii., f. 1*a–d*. (Comm. Serv. Geol. Portugal.)

Conducia; and Petrascheck * records *Acanthoceras* cfr. *Choffati* from the "*labiatus* Pläner" (Turonian) of Leubnitz, in Saxony.

ACANTHOCERAS AFF. CHOFFATI, *Kossmat.*

The collection contains a much-weathered fragment which, though closely allied to *Acanthoceras Choffati*, as seen by the curvature of the ribbing both on the lateral and peripheral areas, nevertheless belonged to a shell with relatively broader whorls than any of the specimens in the collection that we refer to that species. The fragment formed part of the septate portion of the shell, the anterior end exhibiting the greater part of a septal surface. The extreme length of the specimen is about 58 mm.; at about the centre of the specimen the whorl is 23 mm. high and 35 mm. wide, the width of the periphery, as indicated by the rows of marginal tubercles, being 13 mm. The ribs have a sigmoidal curvature on the lateral area and form a slight forwardly-convex curve on the periphery, where they are about 3 mm. wide, and separated by interspaces of nearly the same width.

(*b*) Group of ACANTHOCERAS COLERUNENSE, *Stoliczka.*

To this group is doubtfully referred the following species :—

ACANTHOCERAS CORNIGERUM, *sp. nov.*

(Pl. XIII., Figs. 1, 1*a*.)

Description.—Shell (cast) discoidal, flattened on the sides, with a few rather rapidly increasing whorls; greatest thickness near the umbilical margin, and (excluding the spines) about two-fifths of the diameter of the shell (excluding the spines); height of the outer whorl (excluding the spines) about three-eighths of the diameter of the shell (excluding the spines). Whorls few (? exact number); inclusion about one-third; umbilicus with steep, convex walls, about one-third of the diameter of the shell (excluding the spines) in width. Whorl trapezoidal in transverse section, a little wider than high; feebly impressed by the preceding whorl; periphery flattened, rather broad, with subangular margins; sides feebly convex, fairly distinct from the periphery, but passing imperceptibly into the umbilical zone; umbilical zone narrow, convex, and in the adult not sharply defined from the lateral area. Body-chamber not seen. Depth of chambers (?): suture-line imperfectly known—septal surface showing ventral lobe rather narrow; external saddle broad and bifid; first lateral lobe broad, short and trifid, situated slightly ventrad of the middle of the lateral area; first lateral saddle not quite so broad as the first lateral lobe; second lateral lobe small, situated on the umbilical margin. Test (as exhibited by the cast) in the younger stages of growth ornamented with alternately longer and shorter ribs, the latter

* W. Petrascheck, Die Ammoniten der sächsischen Kreideformation (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. xiv., Heft i. and ii.), 1902, p. 21 (151), Pl. iv. (x.), f. 2*a*, *b*.

disappearing in the ephebic stage; the longer ribs, arising in the younger stages of growth on the umbilical zone of the whorl but in the ephebic stage at the suture of the shell, pass backwards and cross the lateral area at first in a feeble forwardly-convex curve, then with a forwardly-concave curve as far as the margin of the periphery, traversing the latter in a forwardly-convex curve which in the ephebic (?) stage becomes more flattened, the rib at the same time becoming thicker, more obtuse, and eventually much less distinct; the shorter ribs arise at about the middle of the lateral area and have the same direction as the longer ones, but at about what appears to be the commencement of the ephebic stage they disappear or almost suddenly assume the aspect of the longer ribs. In the earlier stages of growth each rib bears a feeble tubercle at the middle of the periphery, is angular or almost tuberculated at the peripheral margin, and at about one-third of the width of the lateral area from the peripheral margin bears another feeble angular prominence, but in the ephebic stage the last-mentioned row of prominences as well as the median row of peripheral tubercles gradually disappears, whilst the tubercles on the peripheral margin develop into large spines. At a point on the lateral area a little nearer the umbilical margin than the periphery each of the larger ribs is raised into a strong compressed spine, which becomes relatively much more prominent with age.

Dimensions.

Diameter of shell (excl. spines) ...	63 mm. (1)	
,, ,, (incl. spines) ...	... ...	69 mm. (1)
Height of outer whorl (excl. spines)	24 mm. (0·38)	
,, ,, (incl. spines) ...	... ...	30 mm. (0·43)
Thickness of outer whorl (excl. spines)	26 mm. (0·41)	
,, ,, (incl. spines)	... ...	32 mm. (0·46)
Width of umbilicus	21 mm. (0·33)	21 mm. (0·30)

Observations.—This species is represented in Mr. Anderson's collection by only one specimen, the dimensions of which are given above. It is an internal cast in calcite, but though entirely septate, all that can be seen of the suture-line is exhibited by the septal surface bounding the anterior end of the specimen. The species can readily be distinguished from all the other forms in this collection. Among Indian forms, the only species with which it can be compared is that described by Stoliczka as *Ammonites coloroonensis*,* from the Utatúr Group† of Southern India, but from that species the Natal example can be easily distinguished by the enormous development of the spines on the margin of the periphery and the presence of the spines on the lateral area.

* F. Stoliczka, Cret. Fauna S. India (Pal. Indica), i., Cephalopoda, p. 71, 1864, Pl. xxxvii., f. 4–6.

† Middle and Upper Utatúr *fide* Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 2 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. xi., Heft i.), 1897, p. 127 (20).

9. Genus Desmoceras, *Zittel.*

There has been considerable diversity of opinion in the interpretation of Bayle's *Puzosia* and Zittel's *Desmoceras*.

In 1878, in instituting the genus *Puzosia*, Bayle* gave no diagnosis of the genus, but referred to it the three species, *Puzosia latidorsata*, Michelin, sp. (Pl. xlv., f. 3, 4, 5); *Puzosia Mayoriana*, d'Orbigny, sp. (Pl. xlv., f. 6, 7, 8); and *Puzosia planulata*, J. de C. Sowerby, sp. (Pl. xlvi., f. 1), each of which he well figured, but he did not state which he regarded as the genotype.

The genus *Desmoceras* was founded in 1884 by Zittel,† who recognised in it four distinct groups: (*a*) Group of *Ammonites Beudanti*, d'Orbigny; (*b*) Group of *Ammonites difficilis*, d'Orbigny; (*c*) Group of *Ammonites Emerici*, Raspail; (*d*) Group of *Ammonites planulatus*, J. de C. Sowerby; and (*e*) Group of *Ammonites Gardeni*, Baily; assigning only to Group *d*, in a subgeneric sense, the name *Puzosia* proposed by Bayle. Thus Zittel seems to have been the first to restrict Bayle's genus to the group of *Ammonites planulatus*, J. de C. Sowerby.

In 1887, in his "Manuel de Conchyliologie," Fischer makes no reference to the genus *Desmoceras*, and regards (p. 393) *Puzosia* as a synonym of Bayle's *Lissoceras*.

In 1893 A. de Grossouvre‡ emended Zittel's genus, applying it "more particularly to the species near to *Ammonites latidorsatus*, that" "is to say, to the species with a more or less narrow umbilicus, with" "whorls more or less elevated, but ornamented with very feeble ribs," "or even without ornamentation on the internal cast, and usually" "exhibiting a series of transverse grooves with a median inflection." "In the genus thus comprised, the suture-line is rather developed," "and contains a large number of lobes and saddles decreasing" "regularly in size."

The name *Puzosia* was kept by the same author (p. 171), "for" "the forms of the group of *Ammonites subplanulatus* characterised" "by a rather wide umbilicus, with elevated whorls exhibiting trans-" "verse grooves and falciform ribs which disappear in the neigh-" "bourhood of the umbilicus and are present only on the external" "region of the sides."

"The suture-line," says M. de Grossouvre, "presents a complete" "analogy with that of *Desmoceras*, but it is more reduced, and the" "first lateral lobe is longer than the ventral lobe, whilst in *Desmoceras*"

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* E. Bayle, Explication de la carte géologique de la France, iv., Atlas, 1878, Pls. xlv. (*Puzosia latidorsata* and *P. Mayoriana*) and xlvi. (*P. planulata*). In his work on Les Ammonites de la craie supérieure, 1893, p. 163, A. de Grossouvre states that Bayle took for his type *P. subplanulata* from the Cenomanian. We do not, however find any statement in Bayle's work to this effect.

† K. A. v. Zittel, Handbuch der Palæontologie, Abth. i., Bd. ii., Lief. vii., 1884, p. 465.

‡ A. de Grossouvre, Recherches sur la craie supérieure, Pt. 2, Paléontologie, Les Ammonites de la craie supérieure, 1893, p. 166. M. de Grossouvre's remarks have here been translated into English.

"it is of the same length. The lobes are trifid and proportionately" "a little narrower than in *Desmoceras*. The saddles, closely re-" "sembling each other, are divided into two parts by a rather deep" "lobule, and each part is subdivided in the same manner as in" "*Desmoceras*."

At the same time A. de Grossouvre (p. 165) proposed for Zittel's group of *Ammonites Gardeni*, Baily, the generic name *Hauericeras;* and the three genera *Desmoceras*, *Puzosia*, and *Hauericeras* were placed in the Phylloceratidæ.

M. Ch. Sarasin* has made a study of Zittel's genus *Desmoceras*, but up to the present has only published (in 1897) a preliminary notice of the result of his observations. He restricts the genus *Desmoceras* to (*a*) the group of *Desm. Beudanti* and (*b*) the group of *Desm. difficile*, and includes in the genus *Puzosia*: (*a*) the group of *Puzosia Emerici*, (*b*) the group of *Puzosia Mayoriana*, and (*c*) the group of *Puzosia latidorsata*, three groups which he says constitute an assemblage perfectly homogeneous and clearly characterised, especially by the form of the suture-lines. He considers *Puzosia* to be derived from *Desmoceras*, there being a gradual passage from one genus into the other.

Dr. Kossmat,† however, writing almost immediately afterwards, adopts Zittel's grouping of the genus *Desmoceras*, using Bayle's name, *Puzosia*, and A. de Grossouvre's name, *Hauericeras*, in a subgeneric sense for the groups of *Ammonites planulatus* and of *Ammonites Gardeni* respectively.

In 1895, in the first edition of his "Grundzüge der Palæontologie," Zittel (p. 426) gave as examples of his genus *Desmoceras* (of which he seems to regard Bayle's *Puzosia* in the text as a synonym, but in the illustration as a subgenus—the accompanying illustrations being named *Desmoceras* (*Puzosia*) *Mayorianum* and *Desmoceras latidorsatum* respectively):—*Ammonites difficilis*, d'Orb., *A. ligatus*, d'Orb., *A. strettostoma*, Uhlig, *A. Emerici*, Rasp., *A. Mayorianus*, d'Orb., and *A. planulatus*, Sowerby. He also accepted A. de Grossouvre's genus *Hauericeras* for the group of *H. Gardeni* (p. 427). So far as these genera are concerned, the second edition, published in 1903, is merely a reprint of the first.

In Eastman's translation of the first edition of Zittel's "Grundzüge," published in 1900, Professor Hyatt completely alters Zittel's classification of the Cephalopoda. He recognises (p. 569) as independent genera *Desmoceras*, Zittel (the accompanying illustrations being named *Desmoceras Mayorianum* and *Desm. latidorsatum* respectively); *Puzosia*, Bayle; *Cleoniceras*, Parona and Bonarelli‡

* Ch. Sarasin, Sur les genres *Sonneratia*, *Desmoceras*, *Puzosia* et *Hoplites*: Bull. Soc. géol. France [3], xxv., 1897, No. 5, pp. 449–51.

† F. Kossmat, Unterschungen über die südindische Kreideformation, Pt. 3 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. xi., Heft iii.), 1898, p. 171 (106).

‡ C. F. Parona and G. Bonarelli, Pal. ital., ii., 1896, p. 83; 1897. Hyatt spells the name *Cleonoceras*. Parona and Bonarelli regarded *Ammonites Cleon*, d'Orbigny, as the genotype, and included in the genus also *A. strettostoma*, Uhlig, and *A. Beudanti*, Brongniart.

(proposed by these authors for the group of *Ammonites Beudanti*); and *Hauericeras*, Grossouvre; all of which he places in the family *Haploceratidæ*.

In his account of the Ammonite-fauna of the Mungo limestone in the Cameroons, Dr. F. Solger * deals with the genus *Puzosia*, and gives a diagnosis of the genus based upon the observations of Zittel, Grossouvre, and Kossmat, taking as the type of the genus *P. planulata*, J. de C. Sowerby, sp., and, following Zittel, places it in the *Desmoceratidæ*.

Mr. Anderson's collection includes both forms allied to *Ammonites latidorsatus* and forms allied to *Ammonites planulatus*. In the present paper the former are included in the genus *Desmoceras*, and the latter in the genus *Puzosia*.

The genus *Desmoceras* Zittel, emend. Grossouvre, may then be described as follows:—

Shell more or less narrowly umbilicated, with whorls more or less elevated, ornamented with very feeble ribs, or even devoid of ornamentation on the internal cast, and usually exhibiting a series of transverse grooves with a median inflection. Suture-line well developed, and consisting of a large number of lobes and saddles regularly decreasing in size. First lateral lobe rather wide and nearly as long as the ventral † lobe; external ‡ saddle divided by a rather deep lobule into two unequal parts, of which the external portion is the larger, both divisions being further subdivided. The remaining saddles closely resemble each other and the external saddle. Lateral lobes all of the same form, a little narrower than the saddles, symmetrical and trifid.

DESMOCERAS, *sp.* (*cf.* LATIDORSATUM, *Michelin, sp.*).

(Pl. XIV., Figs. 1, 1*a*.)

1838. *Ammonites latidorsatus*, H. Michelin, Mém. Soc. géol. France, iii., p. 101, Pl. xii., f. 9, 9*a*.

Observations.—A septate specimen in Mr. Anderson's collection evidently belongs to the group of *Desmoceras latidorsatum*, bearing considerable resemblance to some of the Indian forms attributed to this species and its varieties by Stoliczka and by Kossmat. Its dimensions are as follows: Diameter of shell, 43 mm. (1); height of outer whorl, 19 mm. (0·44); thickness of outer whorl, 20 mm. (0·46); and width of umbilicus, 11·5 mm. (0·26). Owing to considerable erosion of one side the thickness of the whorl is not so great as it should be, but even when allowance is made for this erosion the specimen appears to have relatively too narrow whorls and too wide an umbilicus to be referred definitely to *Desmoceras latidorsatum*

* Dr. F. Solger, in Beiträge zur Geologie von Kamerun (by Dr. E. Esch, Dr. F. Solger, Dr. M. Oppenheim, Professor Dr. O. Jaekel), 1904, p. 102.

† Siphonal, of Grossouvre.

‡ First lateral, of Grossouvre.

and its several varieties, which have been identified by Stoliczka* from the Upper beds of the Utatúr Group, and by Kossmat † from the Lower and Middle divisions of the same group in the Trichinopoli district of Southern India. Nevertheless, that it is closely allied to those forms there can be no question. The surface of the specimen is somewhat undulated; it probably possessed sulcations, but these are now obliterated by erosion of the surface.

It is interesting to observe that Dr. Kossmat notes the occurrence of a specimen adhering to an example of *Acanthoceras Newboldi* var. *spinosa*, a form which also occurs in Mr. Anderson's collection.‡

M. Paul Choffat § records *Puzosia latidorsata* as the commonest species in the Cretaceous rocks of Conducia, but those specimens are relatively thicker and less widely umbilicated than the present example. MM. Boule, Lemoine, and Thevenin || have described and figured a variety of *Desmoceras latidorsatum* from the Cenomanian of the north of Madagascar; and from the neighbourhood of Graham Land, in the Antarctic regions, the occurrence of the group of *Desmoceras latidorsatum* is recorded by Professor Kilian.¶

Desmoceras inane, *Stoliczka, sp.*

(Pl. XIV., Figs. 2, 2*a*; 3, 3*a*.)

1865. *Ammonites inanis* (pars), F. Stoliczka, Cretaceous Fauna S. India (Pal. Indica), i., Cephalopoda, p. 121, Pl. lix., f. 13, 13*a* (not f. 14, 14*a*).

1898. *Desmoceras inane*, F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 3 (Beitr. zur Palaönt. u. Geol. Österr.-Ungarns, &c., Bd. xi., Heft 3), p. 172 (107), Pl. xxv. (xix.), f. 6*a*, *b*, *c*; 7*a*, *b*.

Observations.—Dr. Kossmat has already pointed out that Stoliczka united two distinct forms under this name; he selects the original of Stoliczka's f. 13, 13*a*, as the type of the species, and regards Stoliczka's other figured specimen as a variety of *Desmoceras latidorsatum*, Michelin, sp.** Four specimens in Mr. Anderson's collection agree very well with Stoliczka's species as thus restricted by Dr. Kossmat. Their dimensions are as follows:—

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* F. Stoliczka, Cret. Fauna S. India (Pal. Indica), i., Cephalopoda, p. 148, 1865, Pl. lxxiv., f. 1–4.

† F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 3 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. xi., Heft iii.), 1898, p. 172 (107), Pl. xxv. (xix.), f. 2*a*, *b*; 3*a*, *b*; 4*a*, *b*; 5.

‡ See *antea*, p. 199.

§ Paul Choffat, Contributions à la connaissance géologique des colonies portugaises d'Afrique, i., Le Crétacique de Conducia, 1903, p. 21, Pl. v., f. *M*, *N*, *O*, *P*, *Q*, and Pl. vi., f. 1. (Com. Serv. géol. Portugal.)

|| Ann. de Paléont., i., fasc. iv., 1906, p. 188 (16), Pl. xv. (ii.), f. 4, 4*a*, 4*b*.

¶ W. Kilian, in J. Gunnar Andersson, On the Geology of Graham Land, Bull. Geol. Inst. Upsala, vii., 1904–5, [1906], p. 35.

** H. Michelin, Mem. Soc. géol. France, iii., 1838, p. 101, Pl. xii., f. 9, 9*a*.

	(*a*)	(*b*)	(*c*)	(*d*)
Diameter of shell	21·0 mm. (1)	20·0 mm. (1)	19·5 mm. (1)	13·0 mm. (1)
Height of outer whorl...	10·0 mm. (0·47)	10·0 mm. (0·5)	10·0 mm. (0·51)	6·0 mm. (0·46)
Thickness of outer whorl	10·0 mm. (0·47)	10·0 mm. (0·5)	10·0 mm. (0·51)	6·0 mm. (0·46)
Width of umbilicus ...	4·5 mm. (0·21)	3·0 mm. (0·15)	3·0 mm. (0·15)	2·0 mm. (0·15)

The species has only been recorded from Southern India, where it occurs in the Utatúr Group in the Trichinopoli district.

10. Genus Puzosia, *Bayle.*

Shell more or less widely umbilicated, with whorls more or less elevated; ornamented with forwardly-inclined ribs, which are continued over the rounded ventral area but are absent near the umbilicus, also with several forwardly-bent usually rather strong constrictions or varices. Suture-line similar to that of *Desmoceras* but more reduced; first lateral lobe longer than the ventral lobe; lobes trifid and relatively a little narrower than in *Desmoceras;* saddles almost alike, divided by a rather deep lobule into two parts, each of which is subdivided as in *Desmoceras;* several auxiliary lobes present; umbilical portion of suture-line dependent.*

Puzosia planulata, *J. de C. Sowerby, sp., var. nov.* natalensis.

(Pl. XIV., Figs. 4, 4*a*.)

(1827. *Ammonites planulatus*, J. de C. Sowerby, Min. Conch., vi., p. 136, Pl. dlxx., f. 5).

Observations.—In his work on the Cretaceous rocks of Southern India, Dr. Kossmat makes some extremely valuable comparisons between *Puzosia planulata*, J. de C. Sowerby, sp.,† and its near allies. From the Cretaceous rocks of Southern India, Stoliczka‡ recorded this species from the Utatúr, Trichinopoli, and Ariyalúr Groups. Dr. Kossmat,§ however, does not believe the species had such an extensive vertical distribution; he considers that in India it characterises the Cenomanian, occurring only in the Utatúr Group, and that the forms from the higher horizons belong not to the same, but to allied species. Compared with Sowerby's type-specimen,|| from the chalk-marl of Hamsey, Sussex, Dr. Kossmat points out that the examples from the Utatúr Group have the sides of the whorls more convex and the constrictions less sigmoidal.

In Mr. Anderson's collection there are two fairly well-preserved

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* That is, is directed backward, the lobes pointing across the whorl.

† J. de C. Sowerby, Min. Conch., vi., p. 136, 1827, Pl. dlxx., f. 5.

‡ F. Stoliczka, Cret. Fauna S. India (Pal. Indica), i., Cephalopoda, p. 134, 1865, Pl. lxvii., lxviii.

§ F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 3 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. xi., Heft 3), 1898, pp. 112 *et seq.*

|| Now in British Museum collection, register number 9381. Figured also by D. Sharpe, Foss. Moll. Chalk of England (Mon. Pal. Soc.), Pt. 2, 1854, Pl. xii., f. 3.

examples, which are evidently very near Sowerby's species. Their dimensions are as follows:—

	(*a*)	(*b*)
Diameter of shell	34·5 mm. (1)	27·0 mm. (1)
Height of outer whorl	13·5 mm. (0·39)	10·0 mm. (0·37)
Thickness of outer whorl ...	12·0 mm. (0·34)	10·0 mm. (0·37)
Width of umbilicus.....	12·0 mm. (0·34)	9·5 mm. (0·35)

Compared with the type-specimen, which is rather distorted as well as imperfect, these specimens also have more convex sides and less sigmoidally-curved constrictions—characters in which they approach more nearly the Utatúr form which Dr. Kossmat * regards as a variety (*var. Odiensis*) of Sowerby's species, but compared with that variety the African examples have different relative dimensions (as the above table shows) and a somewhat finer sculpture. They may therefore be characterised as a different variety under the name *natalensis*. These specimens bear some resemblance to *Desmoceras Mayorianum* † from the Albian of France, but though the suture-line is not well preserved there is sufficient to show that it agrees more closely with that of *Puzosia planulata* than with that of *Desm. Mayorianum*.

To Sowerby's species, Dr. Kossmat refers the form which Schlüter ‡ described as *Ammonites subplanulatus* from the Cenomanian of Germany. Although in the Indo-Pacific province closely related forms occur, the species itself, according to Dr. Kossmat, has not yet been found there. The poor fragment figured under this name by Schmidt § from the Cretaceous of the Island of Sachalin can scarcely, as Dr. Kossmat observes, be referred to the European species, whilst Whiteaves' *Ammonites planulatus* || from the Queen Charlotte Islands is more involute and has coarser ornaments than Sowerby's species. *Ammonites Daintreei*, Etheridge,¶ an allied form, has been described from Australia, whilst a fragment from Brazil has been doubtfully referred by C. A. White ** to Sowerby's species.

"*Puzosia mayoriana*" †† and several undetermined forms of *Desmoceras* have been recorded from the Cenomanian of Tunis by Pervinquière.‡‡

* F. Kossmat, Untersuchungen über die südindische Kriedeformation, Pt. 3 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. xi., Heft 3), 1898, p. 177 (112), Pl. xxii. (xvi.), f. 5*a*, *b*, 4; Pl. xxiv. (xviii.), f. 1*a*, *b*.

† A. d'Orbigny, Pal. Franç., Terr. crét., i., 1840, p. 267, Pl. lxxix.

‡ C. Schlüter, Cephalopoden der oberen deutschen Kreide, Palaeontographica, Bd. xxi., Lief. 1, 1871, p. 4, Pl. ii., f. 5, 6, 7.

§ Fr. Schmidt, Petrefacten der Kreideformation von der Insel Sachalin, Mém. Acad. Imp. Sci. St. Pétersbourg, sér. vii., xix., No. 3, 1873, p. 13, Pl. i., f. 5–7.

|| J. F. Whiteaves, Mesozoic Fossils, i., Pt. 3, 1884, p. 207, Pl. xxviii., f. 1.

¶ R. Etheridge, Quart. Journ. Geol. Soc., xxviii. (1872), p. 346, Pl. xxiv., f. 1, 2.

** C. A. White, Contributions to the Palæontology of Brazil (Archiv. Mus. Nac. Rio de Janeiro, vii.), 1887, p. 218, Pl. xxv., f. 5, 6.

†† Probably a species more nearly allied to *Puzosia planulata*.

‡‡ L. Pervinquière, Étude géologique de la Tunisie centrale (Carte géol. de la Tunisie), 1903, p. 93.

From the Cenomanian of Madagascar Sowerby's species has been recorded from the western side of the central portion, from the north-west, and from the extreme north of the island.*

PUZOSIA SUBCOMPRESSA, *sp. nov.*

Description.—Another species of *Puzosia* is indicated in the collection by a fragment of a rather large shell consisting of about one-fourth of a turn of the outer whorl, with the adjacent portion of the penultimate whorl and a small part of the antepenultimate whorl. At about the middle of the specimen the transverse section of the whorl is 81 mm. high and 44 mm. wide, the greatest thickness being at about one-third of the width of the lateral area from the umbilical margin; at the same place the umbilical zone is 13 mm. wide, and the exposed portion of the penultimate whorl 14 mm. wide. The whorl is ornamented with fine ribs, about 3 mm. apart, which, arising nearly at the middle of the lateral area, pass in a forwardly-inclined direction across the periphery; also by fine raised widely-spaced (from three to four in a quarter whorl) ribs which pass from the umbilical margin in an almost radial direction and with a feeble forwardly-convex curve across rather more than half the lateral area when they turn rather abruptly forward and assume the direction of the smaller ribs in passing over the periphery. Where the test is better preserved each widely-spaced rib seems to be accompanied posteriorly by a narrow shallow constriction. When complete the whorl of which this specimen forms a part appears to have had the following approximate dimensions: Diameter, about 225 mm. (1); height of outer whorl, 92 mm. (0·40); thickness of outer whorl, 54 mm. (0·24); width of umbilicus, about 71 mm. (0·31). Unfortunately the suture-line is not exhibited.

Observations.—This species comes near *Puzosia Austeni*, Sharpe, sp.,† from the Grey Chalk (Cenomanian) of the South of England, but apparently it was a more robust shell, whilst from such forms as *Puzosia planulata*, J. de C. Sowerby, sp.,‡ the present specimen is readily distinguished by possessing raised ribs instead of the constrictions, which constitute so distinctive a character on the internal casts of the shells of those species. Compared with the form described by Dr. Kossmat § from the Utatúr Group in Southern India as a new variety (var. *odiensis*) of *Puzosia planulata*, J. de C. Sowerby, sp., the African species was a more compressed shell with whorls increasing more rapidly in height, whilst its less compressed shell, the more rapid

* M. Boule, Bull. Mus. hist. nat., Paris, i., 1905, No. 5, p. 184. E. Haug, Bull. Soc. géol. France [3], xxvii., 1899, No. 4, p. 396. M. Boule, P. Lemoine, and A. Thevenin, Ann. de Paléont., i., fasc. iv., 1906, p. 189 (16), Pl. xvii. (iv.), f. 1.

† D. Sharpe, Foss. Moll. Chalk of England (Mon. Pal. Soc.), Pt. 2, 1854, p. 28, Pl. xii., f. 1*a*, 1*b*. Grossouvre (*op. cit.*, p. 175) regards f. 2 as a distinct species.

‡ J. de C. Sowerby, Min. Conch., vi., p. 136, 1827, Pl. dlxx., f. 5.

§ F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 3 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. xi., Heft 3), 1898, p. 177 (112), Pl. xxii. (xvi.), f. 5*a*, *b*, 4; Pl. xxiv. (xviii), f. 1*a*, *b*.

increase in the height of its whorls, the absence of broad sulci on its internal cast, and its narrower umbilicus, distinguish it from Dr. Kossmat's *Puzosia compressa.** It bears some resemblance to *Puzosia corbarica*, Grossouvre,† but that species is more coarsely ornamented and has its principal ribs much more strongly developed near the umbilicus than the present specimen.

Puzosia Stoliczkai, *F. Kossmat.*

1865. *Ammonites Beudanti*, F. Stoliczka, Cret. Fauna S. India (Pal. Indica), i., Cephalopoda, p. 142, Pl. lxxi., f. 2–4; Pl. lxxii.
1868. *Ammonites Yama*, F. Stoliczka, Records Geol. Surv. India, i., p. 35.
1898. *Puzosia Stoliczkai*, F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 3 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. xi., Heft 3), p. 184 (119), Pl. xxiv. (xviii.), f. 6.

Observations.—A single example in the collection appears to be referable to this species. With the exception of a small piece of the outer whorl, it consists of the natural cast of the half of an example, about 82 mm. in diameter, and in its general appearance agrees very well with Stoliczka's Pl. lxxi., f. 3, the whorls being, however, a little more compressed than are represented in his fig. 3*a*. Originally described as *Ammonites Beudanti* and afterwards regarded as *Amm. Yama*, Dr. Kossmat has referred the Indian form to a new species, *P. Stoliczkai*, the dimensions of which he gives as follows: Diameter of shell, 126 mm. (1); height of outer whorl, 60 mm. (0·48); thickness of outer whorl, 41 mm. (0·33); height of penultimate whorl, 25 mm. (0·2); thickness of penultimate whorl, 19 mm. (0·15); width of umbilicus, 28 mm. (0·22). Mr. Anderson's specimen has the following dimensions: Diameter of shell, about 82 mm. (1); height of outer whorl, 39 mm. (0·47); thickness of outer whorl, 25·5 mm. (0·31); height of penultimate whorl, 17 mm. (0·20); thickness of penultimate whorl, 12·5 mm. (0·15); width of umbilicus, 20 mm. (0·24). From these measurements it will be seen that as regards dimensions the Natal form differs from the Indian only very slightly as regards the thickness of the whorl and the width of the umbilicus. In about one-fourth of the outer whorl there are between three and four constrictions having a distinctly forward inclination; they have a slight forwardly-convex curve at about the middle of the lateral area, and are produced considerably forward at the periphery, whilst portions of the test that are preserved show that on the periphery the posterior boundary of each was marked by a considerable thickening

* F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 3 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. xi., Heft 3), 1898, p. 184 (119), Pl. xxiv. (xviii.), f. 4.

† A. de Grossouvre, Recherches sur la craie supérieure, Pt. 2, Paléontologie, Les Ammonites de la craie supérieure, 1893, p. 174, Pl. xxvii., f. 1*a*, *b*.

of the test. Some of the suture-lines are shown on the exposed part of the penultimate whorl, but though on the outer whorl there are only obscure traces of the umbilical portion of the septa, these suffice to show that the specimen possessed a deep sutural lobe. In Southern India *P. Stoliczkai* occurs in the Utatúr Group (Lower part, *fide* Kossmat). It has also been recorded from Persia.*

Among the forms from Madagascar, the specimen figured by MM. Boule, Lemoine, and Thevenin, Ann. de Paléont., i., fasc. iv., 1906, Pl. xvi. (iii.), f. 3—*Desmoceras* (*Puzosia*) *insculptum*—most nearly resembles the present example, but it has a narrower umbilicus.

Puzosia subtilis, *sp. nov.*

(Pl. XIV., Figs. 5, 5*a*).

Description.—Shell discoidal, umbilicated, compressed, with a few rapidly expanding whorls; greatest thickness at about two-fifths of the height of the whorl from the umbilicus, about three-tenths of the diameter of the shell; height of outer whorl about five-elevenths of the diameter of the shell. Whorls (? number); inclusion about two-thirds; umbilicus deep, with steep, slightly convex walls, and a fairly well-defined margin, about one-fifth of the diameter of the shell wide. Whorl elongate oval in transverse section, height about one and a half times the width; indented to about two-sevenths of its height by the preceding whorl; periphery evenly convex, passing imperceptibly into the flattened and convergent sides; umbilical zone fairly well defined, slightly convex, steeply inclined, but not quite perpendicular, to the mesal plane of the shell. Body-chamber and aperture not seen. Depth of chambers not known; suture-line very imperfectly known, only a portion of the septal surface seen. Test ornamented with fine lines of growth that rise almost vertically from the suture of the shell, but on reaching the umbilical shoulder turn forward and cross the whorl with a distinctly forward inclination; crossing the periphery in an orad-convex curve, and disappearing on the sides, there are fine ribs about two millimetres apart, whilst at intervals there are varices (about three in a half-whorl) which have a similar direction on the periphery, but disappear on the sides, their position, however, judging from a feeble sulcus on the internal cast near the anterior extremity of the specimen, being probably indicated on the internal cast by feeble sulci. The median portion of the periphery bears also a number of faint longitudinal striæ.

Dimensions.

Diameter of shell, about ...	164·0 mm.	(1)
Height of outer whorl	77·0 mm.	(0·47)
Thickness of outer whorl ...	51·0 mm.	(0·31)
Width of umbilicus	33·0 mm.	(0·20)
Height of penultimate whorl ...	33·5 mm.	(0·20)
Thickness of penultimate whorl	21·5 mm.	(0·13)

* H. Douvillé, Bull. Soc. géol. France [4], iv., 1904, p. 542.

Observations.—The above diagnosis is obviously imperfect, having been drawn up upon a single specimen, consisting of about half a shell having a diameter of about 164 mm., with the ventral part of the anterior portion of the whorl missing. Unlike most of the specimens the test is preserved over nearly the whole of the fossil. The specimen closely resembles the largest example of *Puzosia Bhima* figured by Stoliczka * (Pl. lxix., f. 2, 2*a*), to which species I was at first inclined to refer the fossil; but having made as accurate measurements as possible of the specimen, it seems to have been a more compressed shell, with relatively higher whorls and a smaller umbilicus; the relatively greater compression is much more apparent in the younger whorls. The trivial name *subtilis* is, therefore, proposed for it. *Puzosia Bhima*, Stoliczka, its nearest ally, occurs in the Utatúr Group (lower portion *fide* Kossmat) † of Southern India.

PUZOSIA PINGUIS, *sp. nov.*

Description.—Shell discoidal, inflated, umbilicated, composed of a few rapidly increasing whorls; greatest thickness at about one-third of the height of the whorl from the umbilicus, nearly one-third of the diameter of the shell; height of outer whorl nearly one-half of the diameter of the shell. Whorls few (? exact number); inclusion about two-thirds; umbilicus deep, with walls step-like and nearly perpendicular to the mesal plane, with a subangular margin, about one-fourth of the diameter of the shell in width. Whorl truncated oval in transverse section, higher than wide; indented to nearly one-fourth of its height by the preceding whorl; periphery broadly convex, passing imperceptibly into the sides; sides feebly convex, convergent; umbilical zone moderately well defined, feebly convex, steeply inclined, but not quite perpendicular to the mesal plane of the shell. Length of body-chamber and aperture not seen. Depth of chambers not known; suture-line imperfectly known. Test mostly nearly smooth or with only fine lines of growth; the outer or peripheral portion with faint narrow ribs, which arise at about three-fifths of the width of the lateral area from the edge of the umbilicus, pass abruptly forward and cross the periphery without interruption in an orad-convex curve; also with a number of raised ribs, which, arising at the umbilical margin, are feeble, and have a nearly radial direction over about three-fifths of the width of the lateral area, then turning abruptly forward and gradually increasing in strength, cross the periphery parallel to the feeble ribs just mentioned, attaining their greatest thickness at the middle of the periphery.

* F. Stoliczka, Cret. Fauna S. India (Pal. Indica), i., Cephalopoda, p. 137, 1865, Pl. lxix., f. 1–3.

† F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 3 (Beitr. sur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. xi., Heft 3), 1898, p. 184 (119).

Dimensions.

Diameter of shell, about ...	...	215 mm. (1)
Height of outer whorl ...	...	100 mm. (0·46)
Thickness of outer whorl	...	78 mm. (0·36)
Width of umbilicus, about	...	52 mm. (0·24)

Observations.—This species is based upon two fragments. One of these, the more nearly complete of the two, consists of about one-third of a whorl, which, when complete, had a diameter of about 215 mm., and to which is attached a portion of the penultimate whorl and a small portion of the ante-penultimate whorl. When perfect the whorl had approximately the dimensions given above. On the surface of the posterior portion of the outer whorl there is the floor of another whorl, bearing on what was originally its inner surface, the edges of the dorsal part of a septum, apparently the last septum or that forming the base of the body-chamber, showing that the umbilical portion of the suture-line was very dependent or formed a deep sutural lobe; the line of involution on the whorl shows the involution to have been fully two-thirds. This one-third of a whorl bears three raised ribs; these arising at the margin of the umbilicus cross rather more than one-half of the lateral area in a nearly radial direction, then turning abruptly forward they become stronger and pass with an orad-convex curve over the periphery, on which they are slightly more thickened than elsewhere. These ribs are about 50 mm. apart at their point of forward inflection on the lateral area, and about 85 mm. apart at the middle of the periphery. The greater part of the test is nearly smooth, apparently marked only by lines of growth, but the outer two-fifths of the lateral area bear feeble ribs having a direction parallel to the peripheral portion of the longer raised ribs.

The other specimen that we refer to this species is a fragment of a still larger whorl, its transverse section at about its mid-length being 134 mm. high and 93 mm. wide. The raised ribs are relatively nearer together, being only about 50 mm. apart at the middle of the lateral area and a little more than 65 mm. apart at the middle of the periphery. The specimen appears to be entirely septate, and, if so, the species must have attained a large size.

By its inflated whorls and relatively small umbilicus, this species is readily separated from the rest of the fossils in Mr. Anderson's collection.

B. NAUTILOIDEA.

The scheme adopted for the description of the Nautiloidea is essentially that used for the Ammonoidea in the preceding part of this Report. For specifying the position of the siphuncle the terms suggested by Professor Hyatt in his paper entitled "Phylogeny of" "an Acquired Characteristic" (Proc. Amer. Philos. Soc., xxxii., No. 143, Appendix, pp. 429–430, 1894) have been adopted.

Genus Nautilus, *Linn.* (ex *Breyn*), restricted.
(Syst. Nat., 1758, Ed. X., p. 708.)

The representatives of the family Nautilidæ in Mr. Anderson's collection are here grouped together under the generic name *Nautilus;* of these, however, *Nautilus imbricatus* and *N. striaticostatus* are referable to *Cymatoceras*, Hyatt;* *N. ovoideus* to *Eutrephoceras*, Hyatt; † whilst *N. occlusus*, although probably referable to the latter genus, retains apparently into the ephebic stage, although very feebly, the reticulate character of the test observable in the adult of Hyatt's *Cenoceras*,‡ as well as in the young both of *Eutrephoceras* and of the existing *Nautilus*. Nearly, if not all, the specimens in Mr. Anderson's collection lack the body-chamber.

Nautilus imbricatus, *sp. nov.*
(Pl. XIV., Figs. 6, 6*a*.)

Description.—Shell compressed, with a small umbilicus; greatest thickness at a short distance from the edge of the umbilicus, a little more than one-half of the diameter of the shell; height of outer whorl about three-fifths of the diameter of the shell. Whorls few (? exact number); inclusion almost complete; umbilicus small, with ill-defined margin, walls overhanging, only about one-fourteenth of the diameter of the shell in width. Whorl truncated-elliptical in transverse section, higher than wide; indented to nearly one-third of its height by the preceding whorl; periphery narrowly-convex, passing imperceptibly into the sides; sides feebly convex, convergent, not well defined from the umbilical zone; umbilical zone narrow, overhanging the umbilicus. Length of body-chamber apparently about half a whorl; aperture not seen, but judging from the ornaments, probably with a broad lateral crest near the periphery and a fairly deep V-shaped hyponomic sinus. Depth of chambers not seen; suture-line simply curved, with a broad lateral lobe and broadly rounded ventral saddle. Siphuncle small, dorsocentren.§ Test with broad forwardly-imbricating flattened ribs, which have a radial direction over about two-thirds of the lateral area, and then, turning backwards, pass across the periphery in a rather narrow V-shaped orad-concave curve; ribs occasionally bifurcated on the lateral area.

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* A. Hyatt, Genera of Fossil Cephalopoda, Proc. Boston Soc. Nat. Hist., xxii.. p. 301, January, 1884.

† A. Hyatt, Phylogeny of an Acquired Characteristic, Proc. Amer. Philos. Soc., xxxii., No. 143, Appendix, p. 555, 1894.

‡ A. Hyatt, Genera of Fossil Cephalopoda, Proc. Boston Soc. Nat. Hist., xxii. p. 300, January, 1884.

§ *I.e.*, eccentric and a little nearer the dorsal than the ventral margin of the septum. For Professor Hyatt's terms descriptive of the position of the siphuncle see his Phylogeny of an Acquired Characteristic, Proc. Amer. Philos. Soc., xxxii., No. 143, Appendix, p. 430, 1894.

Dimensions

	(*a*)	(*b*)
Diameter of shell	56 mm. (1)	72·0 mm. (1)
Height of outer whorl ...	33 mm. (0·59)	44·0 mm. (0·61)
Thickness of outer whorl ...	33 mm. (0·59)	37·0 mm. (0·51)
Height of outer whorl above preceding whorl ...	19 mm. (0·34)	28·0 mm. (0·39)
Width of umbilicus ...	4 mm. (0·07)	5·0 mm. (0·069)
Centre of siphuncle :		
(*a*) Below ventral surface	12 mm. (0·21)	18·5 mm. (0·25)
(*b*) Above preceding whorl	7 mm. (0·12)	9·5 mm. (0·13)

Observations.—The present species can be at once distinguished by its compressed form and broad imbricating ribs. It does not appear to be comparable with any species from the Cretaceous rocks of Southern India. It is represented in Mr. Anderson's collection by the two examples the measurements of which are given above, and possibly also by a very small completely septate example having the following dimensions: Diameter of shell, 26 mm. (1); height of outer whorl, 16 mm. (0·61); thickness of outer whorl, 17·5 mm. (0·67); height of outer whorl above preceding whorl, 11 mm. (0·42); umbilicus closed; centre of siphuncle—(*a*) below ventral surface, 8 mm. (0·30); (*b*) above preceding whorl, 3 mm. (0·11). This specimen, limited anteriorly by a septal surface, consists of probably little more than a whorl, the nepionic line being shown, at a short distance behind the anterior end of the specimen, as a fairly deep groove with an orad-concave curve extending from the umbilicus half way across the lateral area; the first part of the whorl is crossed by extremely fine lines forming a broad and fairly deep hyponomic sinus on the periphery; the last fourth of the whorl bears coarse imbricating ribs; the siphuncle is small and not far from the dorsal margin of the septum; and there is also a small annular * lobe. This specimen is relatively thicker than the medium-sized specimen (*a*), which again is relatively thicker than the largest example. If, therefore, these are all correctly referred to one species, this becomes relatively more compressed in passing from the young to the adult stage.

NAUTILUS STRIATICOSTATUS, *sp. nov.*

(Pl. XIV., Figs. 7, 7*a*.)

Description.—Shell inflated, narrowly umbilicated; greatest thickness near the edge of the umbilicus, about three-fourths of the diameter of the shell; height of outer whorl about five-ninths of the diameter of the shell. Whorls probably few (? exact number); inclusion nearly complete; umbilicus deep, funnel-shaped, with convex sides, about one-twelfth of the diameter of the shell in width. Whorl

* A. Hyatt, Phylogeny of an Acquired Characteristic, Proc. Amer. Philos. Soc., xxxii., No. 143, Appendix, p. 429, 1894.

reniform in transverse section, much wider than high; indented to about two-sevenths of its height by the preceding whorl; periphery broadly convex, a little flattened, passing imperceptibly into the sides; sides feebly convex, slightly convergent; umbilical zone convex; umbilical margin prominent, convex, but not sharply defined. Length of body-chamber not completely seen, but apparently occupying rather more than one-half of a whorl; aperture not seen, but, judging from the ornaments, probably with a prominent crest near the peripheral portion of the lateral area, and a deep, broad hyponomic sinus. Chambers rather shallow; suture-line simple. Siphuncle rather large, dorsocentren. Test with broad, flattened ribs, separated by narrow, sharply cut grooves; the ribs pass slightly backwards from the umbilicus across the umbilical zone on to the umbilical shoulder, then in an almost radial direction over three-fourths of the lateral area, when they turn backwards and cross the periphery in a broad orad-concave curve; the whole surface of the test also bears a number of fine raised parallel striæ, having the same direction as the flattened ribs.

Dimensions.

Diameter of shell	86 mm.	(1)
Height of outer whorl	47 mm.	(0·54)
Thickness of outer whorl	63 mm.	(0·73)
Height of outer whorl above preceding whorl	34 mm.	(0·39)
Width of umbilicus	7 mm.	(0·08)
Centre of siphuncle:		
(*a*) Below ventral surface	19 mm.	(0·22)
(*b*) Above preceding whorl	15 mm.	(0·17)

Observations.—This species is based upon a single well-preserved but entirely septate example in Mr. Anderson's collection; its dimensions are given above.

It resembles the forms from the Utatúr Group of Odiam in Southern India that Blanford * and Stoliczka † referred to *Nautilus pseudo-elegans*, d'Orbigny,‡ from the Neocomian of France; especially Stoliczka's Pl. xx., f. 1, 1*a*. Dr. A. H. Foord § was inclined to doubt the identity of the Indian and European forms, an opinion in which we concur. The African form certainly does not agree with d'Orbigny's type-specimen.||

NAUTILUS OVOIDEUS, *sp. nov.*

Description.—Shell ovoid, rather compressed, minutely umbilicated; greatest thickness almost close to the umbilical margin, nearly

* H. F. Blanford, Cret. Fauna S. India, i., Cephalopoda, p. 33, 1861, Pl. xvii., f. 3; Pl. xviii., f. 3, 3*a*, 3*b*; Pl. xix., f. 1, 2; Pl. xx., f. 1, 1*a*.

† F. Stoliczka, *ibid.*, p. 210, 1866, Pl. xciii., f. 3.

‡ A. d'Orbigny, Pal. Franç., Terr. crét., i., 1840, p. 70, Pl. viii., ix.

§ Dr. A. H. Foord, Cat. Foss. Ceph. Brit. Mus. (Nat. Hist.), Pt. 2, 1891, p. 257.

|| For figure of type-specimen, see Cat. Foss. Ceph. Brit. Mus. (Nat. Hist.), Pt. 2, 1891, p. 255, f. 59*a*, *b*.

two-thirds of the diameter of the shell; height of outer whorl about four-sevenths of the diameter of the shell. Whorls few (? exact number); inclusion almost complete; umbilicus deep, very small. Whorl semi-elliptical in transverse section, a little wider than high; indented to nearly one-third of its height by the preceding whorl; periphery broadly convex, continuous with the sides; sides convex, convergent, continuous with the rounded periphery and passing imperceptibly into the umbilicus without forming any distinct umbilical margin; umbilical zone convex, steep, imperfectly defined. Length of body-chamber not seen; aperture unknown, peristome not seen, but, judging from the ornaments, probably with a broad and fairly deep hyponomic sinus. Chambers rather deep, apparently about thirteen in the whorl; suture-line simple. Siphuncle extracentro-ventran. Test with fine lines of growth occasionally raised into ridges, which form a broadly rounded crest on the lateral area near the periphery, and a broad moderately-deep hyponomic sinus on the periphery; at the margin of the umbilicus the ribs are more prominent than elsewhere and form narrow plications which have an orad-concave curve and extend over the umbilical zone.

Dimensions.

	(*a*)	(*b*)	(*c*)	(*d*)
Diameter of shell...	111 mm. (1)	103 mm.* / 86 mm. (1)	93 mm. (1)	75 mm. (1)
Height of outer whorl	64 mm. (0·57)	about 47 mm. (0·54)	53 mm. (0·57)	45 mm. (0·60)
Thickness of outer whorl	about 74 mm. (0·66)†	58 mm. (0·67)	59 mm. (0·63)	52 mm. (0·69)
Height of outer whorl above preceding whorl ...	43 mm. (0·38)	?	about 30 mm. (0·32)	26 mm. (0·34)
Width of umbilicus	4 mm. (0·03)	?	4 mm. (0·04)	3 mm. (0·04)
Centre of siphuncle:				
(*a*) Below ventral surface ...	?	?	about 11 mm. (0·12)†	15 mm. (0·2)
(*b*) Above preceding whorl	?	?	about 19 mm. (0·20)‡	11 mm. (0·14)

Observations.—This species is represented in Mr. Anderson's collection by four completely septate examples, the dimensions of which are here given; the smallest specimen but one is the best preserved, and has largely formed the basis of the foregoing description; portions of its test are well preserved, and exhibit the ornaments very clearly. The smallest specimen is very incomplete, but exhibits the younger whorls; up to a diameter of 19 mm. its surface is feebly cancellated, the transverse striæ then become more distinct, whilst the longitudinal ones disappear; at a diameter of 34 mm., where the thickness of the whorl is 26 mm., the height 21 mm., and

* The greatest diameter of this fossil is 103 mm., but its dimensions can be best taken at a diameter of 86 mm.; the other dimensions therefore are given at this diameter.

† Specimen incomplete on one side.

‡ Only approximate; what appears to be the siphuncle is seen in the antepenultimate chamber that is preserved. There are indications of three septa anterior to the portion of the septal surface at the front of the specimen.

the height above the preceding whorl 15 mm., the siphuncle is nearer the dorsal than the ventral margin of the septum, being almost exactly at one-third of the height of the septum above the preceding whorl, whilst at its greatest diameter (75 mm.) the siphuncle is much more nearly central.

From the rest of the Nautili in this collection this species can be readily distinguished by its ovoid form, its finely striated test, and its small umbilicus.

NAUTILUS OCCLUSUS, *sp. nov.*

Description.—Shell medium-sized, rather inflated, with closed umbilicus; greatest thickness at the closed umbilicus, about five-sixths of the diameter of the shell; height of outer whorl about three-fifths of the diameter of the shell. Whorls few (? exact number); inclusion complete; umbilicus closed by shelly callus. Whorl semi-elliptical in transverse section, wider than high; indented to nearly one-third of its height by the preceding whorl; periphery broadly convex, continuous with the sides; sides convex, a little flattened, convergent; no umbilical zone. Length of body-chamber, aperture, and peristome not seen. Chambers rather deep, about thirteen or fourteen in half a whorl, suture-line simple, dependent at the closed umbilicus. Siphuncle rather small, extracentroventran. Test nearly smooth, with feeble growth-lines forming a broad, very shallow hyponomic sinus on the periphery, crossed by delicate, close-set longitudinal striæ, producing a very finely reticulated surface.

Dimensions.

	(*a*)	(*b*)	(*c*)	(*d*)
Diameter of shell.....	60·0 mm. (1)	47·0 mm. (1)	38·0 mm. (1)	27·0 mm. (1)
Height of outer whorl	35·5 mm. (0·59)	28·0 mm. (0·59)	23·5 mm. (0·62)	15·5 mm. (0·57)
Thickness of outer whorl	51·5 mm. (0·86)	37·0 mm. (0·78)	28·5 mm. (0·75)	21·0 mm. (0·77)
Height of outer whorl above preceding whorl	24·0 mm. (0·40)	17·5 mm. (0·37)	16·0 mm. (0·42)	11·5 mm. (0·42)
Width of umbilicus...	—	—	—	—
Centre of siphuncle:				
(*a*) Below ventral surface ...	8·0 mm. (0·13)	4·0 mm. (0·08)	7·5 mm. (0·20)	4·5 mm. (0·16)
(*b*) Above preceding whorl	16·0 mm. (0·26)	13·5 mm. (0·28)	8·5 mm. (0·22)	7·0 mm. (0·26)

Observations.—Mr. Anderson's collection includes six examples of this species. Four of these are fairly well preserved—their measurements are given above; a fifth has about the same dimensions as *b*; and a sixth, the largest of all, probably had a diameter when complete of nearly 75 mm. The umbilicus is closed even in the smallest specimen. The siphuncle, always much nearer the ventral than the dorsal margin of the septum, gets relatively nearer the ventral surface as the shell grows. The annular lobe is present in *d* (27 mm. in diameter) and in *c* (38 mm. in diameter), but the dorsal edges of three septa preserved on the outer surface of the first part of the outer

whorl of specimen *b* (47 mm. in diameter) show that the lobe is here just disappearing. Only fragments of the reticulated surface of the test have been seen; the longitudinal striæ do not appear to have extended on to the umbilical portion of the lateral area.

Compared with *Nautilus justus*, Blanford,* from the Utatúr Group of Odiam, in Southern India, the African form is a more inflated shell and has a closed umbilicus, whilst from *Nautilus subplicatus*, Philippi,† from the Quiriquina beds of Chili, it is distinguished by its more rapidly expanding but less globose whorls, its closed umbilicus at all stages of growth, and its finely ornamented test.

Mr. Anderson's collection also includes two fragments of rather large shells belonging to the "Group of *Schlœnbachia subtricarinata*, d'Orbigny, sp." (= *Peroniceras*, Grossouvre), but as both the matrix and mode of preservation differ from those of the rest of the specimens, it is most probable that they came from another locality, especially as they appear to represent a rather higher horizon than that indicated by the rest of the collection.

Genus Peroniceras, *A. de Grossouvre.*

(Recherches sur la craie supérieure, Pt. 2, Paléontologie, Les Ammonites de la craie supérieure, 1893, p. 93.)

The name *Peroniceras* was given by Grossouvre‡ to "a group" "of forms presenting rather close affinities with *Mortoniceras* and" "*Gauthiericeras*, but differing from them by their periphery being" "ornamented with three keels and by a much more incised and" "elongated suture-line, which recalls that of *Stoliczkaia*: the first" "lateral lobe is, as in this last genus, rather narrow, and terminated" "by a well-marked fork. The third lateral saddle§ has also its" "upper extremity well below those of the two first." Grossouvre gives *Peroniceras Moureti* as the genotype,‖ and places the genus in the Acanthoceratidæ.

Kossmat,¶ however, does not acknowledge the validity of

* H. F. Blanford, Cret. Fauna S. India (Pal. Indica), i., Cephalopoda, p. 22, 1861, Pl. x., f. 2, 2*a*, 3. F. Stoliczka, *ibid.*, p. 206, 1866, Pl. xciii., f. 2, 2*a*, 2*b*, 2*c*.

† G. Steinmann (Beiträge zur Geologie und Palæontologie von Südamerika, iii., Das Alter und die Fauna der Quiriquina Schichten in Chili. C. Der Cephalopoden der Quiriquina-Schichten), Neues Jahrb., Beil. Bd. x., Heft i., 1895, p. 65, Pl. iv., f. 1*a*, 1*b*, 2*a*, 2*b*, 2*c*, 3*a*.

‡ A. de Grossouvre, Recherches sur la craie supérieure, Pt. 2, Paléontologie, Les Ammonites de la craie supérieure, 1893, p. 93. (Mém. Carte géol. detaillée de la France.)

§ Or if the outermost saddle is termed the external, as is usually the case, this saddle would then be the second lateral. In this genus it is small and its anterior termination below that of either the first lateral, or the external, saddle.

‖ A. de Grossouvre, *op. cit.*, p. 100, Pl. xi., f. 3, 4*a*, 4*b*, 4*c*, and text f. 39.

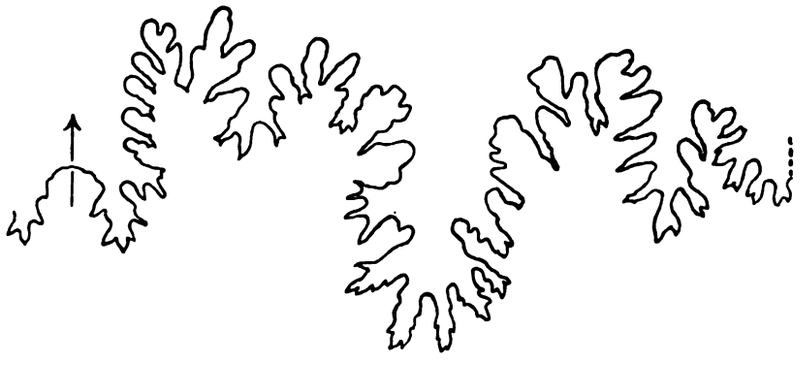
¶ F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 1 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. ix., Heft iii. and iv.), 1895, p. 87 (183).

Grossouvre's genus, and regards it as a subgenus, or group of forms of the genus *Schlœnbachia*, the "Group of *Schlœnbachia subtricarinata*," " d'Orbigny, sp." *

PERONICERAS, *sp.* (*a*).

Grossouvre's *Peroniceras* is represented in Mr. Anderson's collection by two fragments of rather large, widely-umbilicated shells.

The longer of the two, about 190 mm. long measured along the centre of the periphery, is entirely septate and formed of the internal cast of five chambers, the sutures, unlike those of most of the specimens in the collection, being plainly shown. The whorl, which increases rather slowly in size, has the following dimensions at about its mid-length: Height of whorl, 72 mm.; thickness (excluding ribs), 56 mm.; ditto (including ribs), 64 mm.; height of whorl at its centre, *i.e.*, height of whorl above preceding whorl, 65·5 mm.; width of impressed zone, 30 mm. It is subquadrate in transverse section, the periphery being broadly convex and the sides nearly parallel, only very slightly convergent. There are three keels on the periphery; of these the median keel is the highest, and, as seen in the cast, is broadly rounded and from 4 to 5 mm. wide; the others are scarcely raised above the general surface of the cast and appear as angular ridges one on each side of, and at a distance of about 11 mm. from the centre of, the median keel. The whorl is ornamented with rather coarse, broadly-rounded ribs, about 6 mm. wide, and, at the middle of the lateral area, about 24 mm. apart. Arising from the margin of the impressed zone, these cross the lateral area with a slightly forward inclination and in a broad orad-concave curve as far as the lateral keel, each bearing an angular projection, evidently the base of a prominent node, at



Suture-line of *Peroniceras, sp.* (*a*); natural size.

a short distance from the keel, but their umbilical portion does not appear to have been raised into a tubercle. The suture-line is rather much incised; the ventral lobe occupies the space between the two lateral keels and is about twice as long as wide; the external saddle

* A. d'Orbigny, Prod. de Paléont., 1850, ii., p. 212.

is wide, divided into two unequal parts by a secondary lobe, the outer part being the smaller of the two, and each of these is again very much subdivided; the first lateral lobe is longer than the ventral, not very wide, occupies about the middle of the lateral area, is much subdivided, and posteriorly has five branches, though its posterior termination may be regarded as bifid; the first lateral saddle is about one-half the width of the external, with its anterior termination of about the same height, and is much subdivided; the second lateral lobe is small, trifid, and about two-fifths of the length of the first lateral lobe; the second lateral saddle is small and narrow, with its anterior termination much lower than that of either the first lateral, or the external, saddle; the small succeeding lobe is on the margin of the impressed zone.

The affinities of this specimen seem to be with *Peroniceras subtricarinatum*, d'Orbigny, sp.,* especially with that form of this species in which all the ribs are simple, and which Grossouvre † recognises as a variety of the species under the name *tridorsata*, Schlüter.‡

According to Grossouvre this species in France is found in the Coniacian (Lower Senonian); in Westphalia it usually occurs in the Emscherian (Lower Senonian), but Dr. Schlüter has also noted its presence in the Turonian (Cuvieri-Pläner), where, however, it is rather rare. From Southern India Stoliczka § recorded it from the Trichinopoli Group of Trichinopoli, but Kossmat || regards this as a new species—*Schlœnbachia* (*Peroniceras*) *Dravidica*—and not referable to d'Orbigny's species. Kossmat has also pointed out that the "Group of *Schlœnbachia subtricarinata*" (= *Peroniceras*, Grossouvre) is represented in the Cretaceous rocks of Pondoland by Baily's *Ammonites Stangeri*. In his recent work on the Pondoland deposits Woods ¶ considers them to be of Campanian age.

Peroniceras, *sp.* (β)

The other example of the genus *Peroniceras* is part of a rather more robust and less widely umbilicated specimen than the one just described. The fragment, about 160 mm. in length measured along the centre of the periphery, consists of the internal cast of the posterior part of the body-chamber and the casts of the three preceding chambers. At about its mid-length its dimensions are: Height of whorl, 78 mm.; thickness (excluding the ribs), 70 mm.; ditto (including

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* A. d'Orbigny, Prod. de Paléont., 1850, ii., p. 212.

† A. de Grossouvre, Recherches sur la craie supérieure, Pt. 2, Paléontologie, Les Ammonites de la craie supérieure, 1893, p. 94. (Mém. Carte géol. detaillée de la France.)

‡ C. Schlüter, Beitrag zur Kenntniss der jungsten Ammoneen der nördlichen Deutschland, 1867, p. 26, Pl. v., f. 1.

§ F. Stoliczka, Cret. Fauna S. India (Pal. Indica), i., Cephalopoda, p. 54, 1863, Pl. xxxi., f. 3, 3*a*, 3*b*, 3*c*.

|| F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 1 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. ix., Heft iii. and iv.), 1895, p. 94 (190).

¶ H. Woods, Ann. S. African Museum, iv., Pt. vii., 1906, pp. 344 *et seqq.*

the ribs), 82 mm.; height of outer whorl above preceding whorl, 67 mm.; width of impressed zone, about 40 mm. The whorl is subquadrate in transverse section, the periphery broadly-convex, and provided with three keels, one median, the largest, and one on each side at about 16 mm. from the centre of the periphery. Compared with the specimen just described the ribs are straighter, have a more nearly radial direction, are more prominent near the umbilicus, and bear relatively larger tubercles near the periphery; the periphery is a little more flattened and relatively broader; the sides also are rather more convergent. The suture-line, not so well preserved as in the other specimen, has a relatively broader first lateral lobe. Although at first inclined to refer the two fossils to the same species, it seems hardly possible that such is the case; the two species, however, are very closely allied. Both specimens are undoubtedly from the same horizon and locality.

With the collection from False Bay was also a specimen (Pl. XV., Figs. 9, 9*a*) from Umkwelane Hill referable to the genus *Mortoniceras*, Meek. The transverse section of the fossil at its anterior end is subquadrate, a little wider than high. Though related to the Pondoland forms *Mortoniceras Soutoni* and *M. Stangeri* * it is specifically distinct therefrom and may be named *M. umkwelanense.*

III. GEOLOGICAL RESULTS.

The nearest outcrop of Cretaceous rocks hitherto described is some few miles to the west of False Bay, at the Umsinene River, which flows into the north end of False Bay. The fauna, described by Mr. Etheridge in the present Report, includes only three Cephalopods, viz.: *Douvilléiceras* (?) *nodosum*, n. sp.; *Desmoceras*, sp.; and *Hamites* (?), sp. The False Bay deposit contains no specimen resembling either the Hamite or the example doubtfully referred to the genus *Douvilleiceras*, but the fossil regarded as *Desmoceras*, sp., resembles some of the forms described in the preceding pages as *Puzosia*, although it does not actually agree with any one of them. Anderson † identifies this locality as probably the one in Zululand mentioned by Griesbach, who recorded there the existence of the Umtamvuna (or Umzamba) beds.

About forty miles farther south, just to the south of the Umfolosi River, which flows into St. Lucia Bay, there is the Umkwelane Hill Deposit, the fauna of which was described by Mr. Etheridge in the Second Report of the Geological Survey of Natal (1904, p. 93). The Cephalopoda of this fauna included two new species of *Placenticeras*, an undetermined species doubtfully referred to the genus

* For reference see H. Woods, Ann. S. African Museum, iv., Pt. vii., 1906, pp. 337 and 338.

† First Report Geol. Surv. Natal, 1901, p. 48.

Creniceras, a fragment of *Hamites*, and a piece of *Baculites*; but none of these forms are represented in the False Bay Deposit. Comparing the fauna with that of the Umtamvuna (or Umzamba) beds in Pondoland, Mr. Etheridge says:* "*Puzosia Gardeni*, Baily, sp.," "has not been observed in the present collection, nor any of the" "Ammonites mentioned as occurring in Griesbach's stratum *c*, nor" "*Teredo*-bored wood as in *e* of the same author. The fauna of" "the Umkwelane Hill Deposit consists, with few exceptions, of" "bivalves and univalves, like that of Griesbach's stratum *b*, and" "some of the species are identical with those met with in the" "latter. There appears to be a close connection between the" "fossils of the two beds; possibly they may be actually on the" "same horizon." In his recent work on the Cretaceous Fauna of Pondoland, Mr. Woods† regards the Umkwelane Hill Deposit as of the same age as the Cretaceous rocks of Pondoland.

In his monograph on the "Pseudoceratites of the Cretaceous" Professor Hyatt‡ described *Eulophoceras natalense* from Port Natal, but the False Bay collection contains no fossil that can be referred to that genus.

Still further south, at the mouth of the Umpenyati River, the Umtamvuna (or Umzamba) beds are present,§ but these are well developed in Pondoland to the south of the mouth of the Umtafuna River which is the southern boundary of Natal; they occur for some twelve miles farther south, as far as the Umtentu River, being well represented at the mouth of the Umzamba River. These beds have yielded a rich fauna which has recently been described by Mr. Woods,|| who concludes that they are of Campanian (Upper Senonian) age. But none of the False Bay Cephalopods are represented in this fauna.

The other Cretaceous beds in Cape Colony, the so-called Uitenhage Beds, yield a fauna which has distinctly Neocomian characters and shows no relation whatever to the False Bay fauna.

In a northerly direction from False Bay the Cretaceous deposits of the Manuan Creek are only at a comparatively short distance; these are considered in the next part of this Report.

Between Lake St. Lucia and Lourenço-Marques, Molengraaff,¶ in his map of the Transvaal, indicates three outcrops of the Cretaceous; and in a preliminary note Professor Kilian** has recorded the existence of an Aptian fauna at Delagoa Bay.

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* Second Report Geol. Surv. of Natal, 1904, p. 93.

† H. Woods Ann. S. African Museum, iv., Pt. vii., 1906, p. 347.

‡ A. Hyatt, Pseudoceratites of the Cretaceous, Mon. U. S. Geol. Surv., xliv., 1903, p. 86, Pl. xi., f. 2–6.

§ See C. L. Griesbach, Quart. Journ. Geol. Soc., xxvii., 1871, p. 53; and F. H. Hatch and G. S. Corstorphine, Geology of Cape Colony, 1905, p. 256.

|| H. Woods, Ann. S. African Museum, iv., Pt. vii., 1906, pp. 275–350, Pls. xxxiii.–xliv.

¶ Bull. Soc. géol. France, sér. 4, i., 1901, Pl. i.

** W. Kilian, Sur quelques gisements de l'étage aptien, Bull. Soc. géol. France, sér. 4, ii., 1902, p. 358; Sur le présence de l'étage Aptien dans le Sud-Est de l'Afrique, Comptes rendus, cxxxv., No. 1 (7 Juli, 1902), pp. 68–71; Ueber Aptien in Südafrika, Centralbl. für Mineral. Geol. und Palaeont., No. 15 (August 6, 1902), pp. 465–8.

Farther north, on the coast at Sofala, Mr. R. Bullen Newton * has demonstrated the existence of the uppermost Cretaceous deposits by the occurrence of *Alectryonia ungulata;* and M. Paul Choffat † has also already mentioned the existence of similar deposits in the immediate vicinity.

Still further north, from rocks near the mouth of the Conducia River, which debouches into the Indian Ocean a little north of Mozambique, a Cretaceous fossil was first made known by Neumayr,‡ who believed it to belong to *Phylloceras semistriatum*, d'Orbigny, sp., and to be of Neocomian age, but comparatively recently M. Paul Choffat § has described from the same neighbourhood, and most probably from the same rocks, a fauna, composed principally of Cephalopods, the age of which he regards as from Vraconnian to Cenomanian. Lemoine || considers them to be of Cenomanian age. Some of the forms closely resemble those from False Bay.

Cretaceous rocks have also been described in German East Africa.¶

The fauna from the north end of False Bay is undoubtedly of Cenomanian age.

The Cenomanian fauna which has been recorded,** and is being described,†† from the north of Madagascar, presents a striking resemblance to the False Bay fauna. Several of the species, which, up to the present, have been characterised, are represented in the False Bay deposit, and doubtless when the whole fauna has been described, the similarity between the two faunas will be very apparent.

The False Bay fauna also shows great analogy to that of the Utatúr Group in the Trichinopoli district of Southern India, particularly with its Middle and Lower portions. According to Dr. Kossmat,‡‡ the equivalents of this group are as follows:—Upper Utatúr = Lower Turonian; Middle Utatúr = Upper and Middle Cenomanian; Lower Utatúr = Lower Cenomanian (Vraconnian).

It is interesting to note that, from Snow Hill Island and Seymour Island off the coast of Graham Land in the Antarctic regions, the recent Swedish Antarctic expedition obtained a cretaceous fauna, the greater

* R. B. Newton, Journ. Conch., viii., January, 1906, pp. 136–51.

† P. Choffat, Actes Soc. Linn. Bordeaux, Comptes rendus des séances, 16 Juillet, 1902.

‡ M. Neumayr, Denkschr. d. k. Akad. d. Wissensch., Math.-naturw. Cl., Wien, Bd. l., 1885, pp. 110 and 139, Pl. i., f. *2a*, *2b*.

§ Paul Choffat, Contributions à la connaissance géologique des colonies portugaises d'Afrique, i, Le Crétacique de Conducia. 1903. (Com. Serv. géol. Portugal.)

|| P. Lemoine, Études géologiques dans le nord de Madagascar, 1906, p. 396.

¶ G. Müller, Versteinerungen des Jura und der Kreide, Deutsch. Ost-Afrika, Bd. vii., 1900, pp. 540–71.

** For references see P. Lemoine, Études géologiques dans le nord de Madagascar, 1906.

†† M. Boule, P. Lemoine, and A. Thevenin, Ann. de Paléont., i.

‡‡ F. Kossmat, Die Bedeutung der südindischen Kreideformation, &c.; Jahrb. d.k.k. geol. Reichsanst., Wien, Bd. xliv. (1894), Heft. iii. and iv. (April, 1895), p. 460; and Records Geol. Surv. India, xxviii., Pt. 2, May, 1895, p. 40.

number of the Cephalopoda of which are, according to Professor W. Kilian,* either identical with, or similar to, species characterising the Trichinopoli (Upper), Ariyalúr, and Valudayur groups in India—that is to say, the Senonian ; whilst some few species indicate a somewhat lower horizon, that of the Upper Utatúr, the equivalent of the Turonian, though the most characteristic forms (*Schlœnbachia*, *Acanthoceras*, &c.) of this group are wanting.

The False Bay fauna also exhibits analogy to that of the Cenomanian of Europe.

* W. Kilian, Comptes Rendus, cxlii., No. 5 (Jan. 29, 1906), pp. 306–308; and Bull. Geol. Inst. Upsala, vii., 1904–5, [1906], pp. 35, 36.

LIST OF THE CEPHALOPODA FROM THE NORTH END OF FALSE BAY, ZULULAND.

False Bay Species.	Allied or Identical Species from India.	Horizon.	Allied or Identical Species from Countries other than India.	Horizon.	Page.
Phylloceras Velledæ, *Stol., sp.*	Phylloceras Velledæ, *Stol., sp.*	Lower Utatúr Group, S. India.	Ph. Velledæ, *Mich., sp.* (Europe, N. Africa, Sachalin, ? Yesso, Madagascar; ? Graham Land, Antarctic Regions).	Albian and Cenomanian.	166
Phylloceras cf. ellipticum, *Kossmat.*	Phylloceras ellipticum, *Kossmat.*	Lower Utatúr Group, S. India.			169
Gaudryceras Sacya, *Forbes, sp.*	Gaudryceras Sacya, *Forbes, sp.*	Lower Utatúr Group, S. India.	Gaud. Sacya, *Forbes, sp.* (E. Africa, ? Madagascar, Yesso, Sachalin, Queen Charlotte Islands, and California).	Middle Cretaceous.	170
Gaudryceras odiense, *Kossmat.*	Gaudryceras odiense, *Kossmat.*	Lower Utatúr Group, S. India.			171
Tetragonites Timotheanus, *Stol., sp.*	Tetragonites Timotheanus, *Stol., sp.*	Lower Utatúr Group, S. India.	Tetrag. Timotheanus, *Mayor, sp.* (Europe, Madagascar, Sachalin, Queen Charlotte Islands).	Upper Albian and Cenomanian.	172
Turrilites Scheuchzerianus, *Bosc.*			Turr. Scheuchzerianus, *Bosc* (Europe and N. Africa).	Cenomanian.	173
Turrilites costatus, *Lamk.*	Turrilites costatus, *Lamk.*	Middle Utatúr Group, S. India.	Turr. costatus, *Lamk.* (Europe, N. Africa, and Tibet).	Cenomanian.	174
Turrilites acutus, *Passy.*	Turrilites circumtæniatus, *Kossm.*	Lower Utatúr Group, S. India.	Turr. acutus, *Passy* (Europe and N. Africa).	Cenomanian.	176
Turrilites nodiferus, *G. C. Crick.*	Turrilites Cunliffeanus, *Stol.*	Middle Utatúr Group, S. India.	Turr. Gravesianus, *d'Orb.* (Europe).	Cenomanian.	177
Baculites sp.	Baculites teres, *Stol.* (*non Forbes*).	Utatúr Group, S. India.			179
Knemoceras (?) cornutum, *G. C. Crick.*					179
Forbesiceras Largilliertianum, *d'Orbigny, sp.*	Forbesiceras Largilliertianum, *d'Orbigny, sp.*	Utatúr Group, S. India.	Forb. Largilliertianum, *d'Orb., sp.* (Europe, Tunis).	Cenomanian.	180
Forbesiceras sculptum, *G. C. Crick.*			Forb. obtectum, *Sharpe, sp.* (England).	Cenomanian.	182
Forbesiceras nodosum, *G. C. Crick.*	Forbesiceras subobtectum, *Stol., sp.*	Utatúr Group, S. India.			182

LIST OF THE CEPHALOPODA FROM THE NORTH END OF FALSE BAY, ZULULAND (*Continued*).

False Bay Species.	Allied or Identical Species from India.	Horizon.	Allied or Identical Species from Countries other than India.	Horizon.	Page.
Acanthoceras flexuosum, *G. C. Crick.*			Acanth. rotomagense, *Defr.*, *sp.* (Europe, N. Africa, W. Asia).	Upper Cenomanian.	184
Acanthoceras crassiornatum, *G. C. Crick.*			,, ,, ,,	Upper Cenomanian.	185
Acanthoceras munitum, *G. C. Crick.*					187
Acanthoceras expansum, *G. C. Crick.*					188
Acanthoceras robustum, *G. C. Crick.*	Acanthoceras Turneri, *White*, *sp.*	Middle Utatúr Group, S. India.	Acanth. Turneri, *White*, *sp.* (California).	Chico Beds.	189
Acanthoceras sp.					191
Acanthoceras quadratum, *G. C. Crick.*			Acanth. sussexiense, *Mantell*, *sp.* (Europe).	Cenomanian.	192
Acanthoceras hippocastanum, *J. de C. Sowerby*, *sp.*			Acanth. hippocastanum, *J. de C. Sowerby*, *sp.* (Europe).	Cenomanian.	194
Acanthoceras latum, *G. C. Crick.*	Acanthoceras Turneri, *White*, *sp.*	Middle Utatúr Group, S. India.	Acanth. Turneri, *White*, *sp.* (California).	Chico Beds.	195
Acanthoceras Newboldi, *Kossmat.*	Acanthoceras Newboldi, *Kossmat.*	Middle Utatúr Group, S. India.	Acanth. Newboldi, *Kossmat* (England, Syria, Madagascar).	Upper Cenomanian.	
(*a*) typical form.	,, ,,	,,			197
(*b*) var. spinosa.	,, ,,	,,			199
(*c*) var. planicostata.	,, ,,	,,			201
Acanthoceras laticostatum, *G. C. Crick.*	Acanthoceras Newboldi, *Kossmat*, var. planicostata.	Middle Utatúr Group, S. India.			201
Acanthoceras nitidum, *G. C. Crick.*	Acanthoceras Newboldi, *Kossmat*, var. spinosa.	Middle Utatúr Group, S. India.			201
Acanthoceras paucinodatum, *G. C. Crick.*			Acanth. Gentoni, *Brongn.*, *sp.* (Europe, Persia).	Cenomanian.	203

LIST OF THE CEPHALOPODA FROM THE NORTH END OF FALSE BAY, ZULULAND (*Continued*).

False Bay Species.	Allied or Identical Species from India.	Horizon.	Allied or Identical Species from Countries other than India.	Horizon.	Page.
Acanthoceras Choffati, *Kossmat.*	Acanthoceras Choffati, *Kossmat.*	Middle Utatúr Group, S. India.			205
Acanthoceras aff. Choffati, *Kossmat.*	,, ,,	,,			207
Acanthoceras cornigerum, *G. C. Crick.*	Acanthoceras colerunense, *Stol.*, *sp.*	Middle and Upper Utatúr Group, S. India.			207
Desmoceras sp.	Desmoceras latidorsatum, *Michelin*, *sp.*	Utatúr Group, S. India.	Desm. latidorsatum, *Mich.*, *sp.* (Europe; Conducia, Portuguese E. Africa; Madagascar; ? Graham Land, Antarctic Regions).	Albian; Cenomanian.	211
Desmoceras inane, *Stol.*, *sp.*	Desmoceras inane, *Stol.*, *sp.*	Utatúr Group, S. India.			212
Puzosia planulata, var. natalensis, *G. C. Crick.*	Puzosia planulata, *J. de C. Sowerby*, *sp.*	Utatúr Group, S. India.	Puz. planulata, *J. de C. Sowerby*, *sp.* (Europe, Brazil, ?Tunis, Madagascar).	Cenomanian.	213
Puzosia subcompressa, *G. C. Crick.*			Puz. Austeni, *Sharpe*, *sp.* (Europe, N. Africa).	Cenomanian.	215
Puzosia Stoliczkai, *Kossmat.*	Puzosia Stoliczkai, *Kossmat.*	Lower Utatúr Group, S. India.	Puz. Stoliczkai, *Kossmat* (Persia).	Cenomanian.	216
Puzosia subtilis, *G. C. Crick.*	Puzosia Bhima, *Stoliczka*, *sp.*	Lower Utatúr Group, S. India.			217
Puzosia pinguis, *G. C. Crick.*					218
Nautilus imbricatus, *G. C. Crick.*					220
Nautilus striaticostatus, *G. C. Crick.*	Nautilus pseudo-elegans, *Stol.* (*non d'Orb.*).				221
Nautilus ovoideus, *G. C. Crick.*					222
Nautilus occlusus, *G. C. Crick.*					224

II.—THE CEPHALOPODA FROM THE TRIBUTARIES OF THE MANUAN CREEK, ZULULAND.

I.—INTRODUCTION.

In the "First Report of the Geological Survey of Natal and" "Zululand," 1901, Mr. Anderson records (p. 47) the outcrop of Cretaceous rocks at three localities in Zululand that he had been able to visit: (1) Umkwelane Hill, between the Umfolosi River and the Isitesa Lake; (2) at the Umsinene River, some miles west of the north end of False Bay; and (3) in the bed of a creek, about a couple of miles to the east of Crossly's Store, Bombeni, near the southern end of the Lebombo Range. In the "Second Report," 1904, the third locality is spoken of by Mr. Anderson (p. 48) as "the Manuan" "Creek at the south end of the Lebombo Range." It is from this locality that most of the specimens described in the following pages were derived, but five specimens are labelled "Crossing Middle" "Tributary, Manuan Creek." These are described separately from the rest, as it is possible that they indicate a slightly different horizon. Mr. Anderson describes ("First Report," p. 48), the Manuan Creek deposit as follows: "Near Crossly's Store, the rock is a coarse" "calcareous conglomerate, evidently a beach deposit. It is exposed" "in a shallow creek, and is very fossiliferous. As might be expected," "the fossil shells are, as a rule, very imperfect, being much broken" "and worn by attrition. They consist chiefly of large Gasteropoda," "with a much less percentage of Lamellibranchiata, while Cephalopoda" "are rare. This rock has a light yellow calcareous matrix, while the" "pebbles usually consist of quartzites and other altered sedimentary" "rock, with well rounded fragments of amygdaloidal basalts and other" "volcanic rocks. The outcrop occurs at the foot of the eastern slope" "of the Lebombo Range, which is composed of light coloured" "Rhyolitic rock. . . . The outcrop of the conglomerate is of limited" "extent, as it only occurs for a short distance in the bed of the creek," "and then disappears under the Pleistocene and Recent sands of the" "littoral."

II.—DESCRIPTION OF THE SPECIES.

(*a*) SOUTH BRANCH OF THE MANUAN CREEK, ZULULAND.

Most of the specimens in this collection are very fragmentary, and, as already explained, much waterworn; they are therefore difficult of determination. So far as numbers are concerned the Nautiloids predominate over the Ammonoids, although only two, or possibly three, species of the former can be recognised.

A. AMMONOIDEA.

1. Genus Phylloceras, *Suess.*

(Ueber Ammoniten: Sitzungsberichte d. nat.-wiss. Classe d. k. Akad. d. Wissensch., Wien, Bd. lii., Abth. i., 1865 (1866), p. 76.)

Phylloceras, *sp.*

Observations.—A fragmentary specimen closely resembles the species mentioned in the present Report from the north end of False Bay, Zululand, under the name *Phylloceras Velledæ.** It consists of the sector of a whorl, having a radius of about 71 mm. and an angle of 75° or 80°. The umbilical portion is imperfect. Its greatest thickness, evidently not far from the umbilicus, is 41 mm. The specimen is entirely septate. The test is ornamented with fine raised striæ, which, in passing from the umbilical margin, are directed somewhat backward on the lateral area; curving slightly forward near the periphery, they cross the latter in an almost radial direction as fine raised rounded ribs separated from each other by grooves of about their own width; on the anterior portion of the specimen these ribs are about 1·5 mm. wide.

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2. Genus Lytoceras, *Suess.*

(Ueber Ammoniten: Sitzungsberichte d. nat.-wiss. Classe d. k. Akad. d. Wissensch., Wien, Bd. lii., Abth. i., 1865 (1866), p. 78.)

Lytoceras crenulatum, *sp. nov.*

Observations.—The genus *Lytoceras* is represented by a completely-septated fragment of a rather large shell, about 120 mm. long, with a transverse section at its mid-length 85 mm. high and 92 mm. wide. The impressed zone is very narrow, showing the shell to have been very evolute. The transverse section of the whorl is nearly circular, a little wider than high, the greatest width being at about one-third of the width of the lateral area above the lowest part of the whorl. The test is preserved over the greater part of the specimen; it is ornamented with transverse fimbriated striæ which, passing from the margin of the impressed zone, are directed backwards in an orad-concave curve as far as the umbilical margin, then turning forwards they cross the lateral area in a broad orad-concave sweep, and pass over the periphery in a rather narrow, orad-convex curve; at irregular intervals some of the striæ are stronger than the others; between the striæ the test, at least on the sides and on the periphery, is covered with close-set longitudinal striæ.

This specimen evidently formed part of a large shell comparable

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* See *antea*, p. 166.

with *Lytoceras Mahadeva*, Stoliczka, sp.,* from the Utatúr Group (Lower *fide* Kossmat) of Southern India, but the direction of the fimbriated striæ—their forward projection on the sides and their forwardly-concave curve on the periphery—and the presence of the close-set longitudinal striæ serve to distinguish the two species. A somewhat similar species (*Lytoceras ezoense*) has been recorded from the Cretaceous rocks of Japan.†

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3. Genus Gaudryceras, *Grossouvre emend. Kossmat.*

(A. de Grossouvre, Recherches sur la craie supérieure, Pt. 2, Paléontologie, Les Ammonites de la craie supérieure, 1893, p. 225; and F. Kossmat, Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. ix., Heft iii. and iv., 1895, p. 113.)

Group of Gaudryceras Sacya, *Forbes, sp.*

Gaudryceras pulchrum, *nov. sp.*

(Pl. XV., Figs. 1, 1*a*.)

Description.—Shell discoidal, widely umbilicated, with a few slowly-increasing whorls; greatest thickness almost close to the umbilical margin, about two-fifths of the diameter of the shell; height of outer whorl a little more than one-third of the diameter of the shell. Whorls five or six; inclusion nearly one-half; umbilicus shallow, with step-like sides, about three-sevenths of the diameter of the shell in width. Whorl semi-elliptical in transverse section, a little wider than high, but relatively wider in the young; indented to about one-fifth of its height by the preceding whorl; periphery broadly convex, not sharply defined from the lateral areas; sides feebly convex, rather flattened and convergent; umbilical zone not very narrow, fairly well defined, separated from the lateral area by a subangular umbilical margin, feebly convex, sloping towards the centre of the umbilicus. Length of body-chamber and aperture not seen. Suture-line imperfectly seen. Test with slightly-forwardly-directed *f*-shaped varices, about six in a whorl, completely crossing the whorl, and each preceded by a narrow shallow sulcus; the whole surface, including the varices, with exceedingly fine raised lines crossing the whorl in a direction parallel to the varices; these lines are very fine and close-set on the lateral area, but become stronger and rather irregularly-spaced on the periphery.

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* F. Stoliczka, Cret. Fauna S. India (Pal. Indica), i., p. 165, Pl. lxxx., f. 1, 1*a*, 1*b*. See also F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 1 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. ix., Heft iii. and iv.), 1895, p. 16 (112).

† H. Yabe, Journ. Coll. Sci., Imp. Univ., Tōkyō, xviii., Art. 2, 1903, p. 9, Pl. i., f. 1; Pl. v., f. 1.

Dimensions.

	(*a*)	(*b*)	(*c*)
Diameter of shell...	39 mm. (1)	35·0 mm. (1)	22 mm. (1)
Height of outer whorl	14 mm. (0·36)	12·5 mm. (0·35)	7 mm. (0·32)
Thickness of outer whorl	15 mm. (0·38)	14·5 mm. (0·41)	9 mm. (0·41)
Width of umbilicus	17 mm. (0·43)	15·0 mm. (0·43)	11 mm. (0·50)

Observations.—This species is represented by three examples, the dimensions of which are given above. They are well preserved, the largest exhibiting very clearly the delicate characteristic ornaments of the test. Its nearest ally appears to be *Gaudryceras subtililineatum*, Kossmat,* a species founded upon two examples from the Ariyalúr Group in the Trichinopoli district of Southern India. As in that species the whorls are relatively wider in the young, and the test is ornamented with delicate transverse raised striæ, but compared with Dr. Kossmat's figures of that species the Zululand fossils have the lateral area a little more flattened, the greatest thickness of the whorl being at the umbilical margin, which is subangular and fairly distinct. The African form may prove to be only a variety of the Indian species. *Gaudryceras Kayei*, Forbes, sp.,† from the Valudayur beds of Pondicherri in Southern India, a more widely umbilicated shell, with more compressed whorls and much more delicate ornaments than the Zululand fossil, was recorded, but not figured, by Griesbach ‡ from the Umtamvuna (or Umzamba) beds (bed *d*) at the Umtamvuna River, which forms the southern boundary of Natal.

Gaudryceras, *sp.*

(Pl. XV., Figs. 4, 4*a*.)

Observations.—Another species of this genus is represented by a septated fragment about 37 mm. long, measured along the centre of the periphery. The whorl is semi-elliptical in transverse section, about as high as wide, its height and width at its mid-length being 17 mm. and 16 mm. respectively; its height in the mesal plane of the shell is 13 mm. On the periphery, at about 12 mm. from the anterior end of the specimen, there is a varix projected considerably forward at the centre and extending only a short distance on to the lateral area; almost close to the posterior end of the fossil, at a point about 23 mm. behind the varix, where the test is broken off, there is

* F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 1 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. ix., Heft iii. and iv.), 1895, p. 123, Pl. v. (xix.), f. 1*a–c*; 2*a*, *b*.

† E. Forbes, Trans. Geol. Soc. London, 2nd ser., 1846, vii., p. 101, Pl. viii., f. 3. See also F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 1 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. ix., Heft iii. and iv.), 1895, pp. 28 (124) and 66 (162), Pl. ii. (xvi.), f. 5*a*, *b*; Pl. iii. (xvii.), f. 2*a*, *b*.

‡ C. L. Griesbach, Quart. Journ. Geol. Soc., xxvii., 1871, p. 63.

a fairly deep and broad constriction, which is quite distinct on the lateral area, but before reaching the middle of that area it is interrupted by the truncated end of the specimen. Only a portion of the edge of the umbilicus is preserved, but this shows that the shell was rather widely umbilicated. The test is not well preserved, but its surface seems to have borne only feeble lines of growth.

GAUDRYCERAS, *sp.*

Observations.—The collection also includes a fragment consisting of a sector of a shell subtending an angle of about 120° and including portions of three whorls. The shell was widely umbilicated like *Gaudryceras pulchrum*, but had more compressed whorls. It is, however, so much weathered as to be specifically indeterminable.

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4. GENUS ANISOCERAS, *F. J. Pictet.*

(Traité de Paléontologie, Ed. 2, 1854, tom. 2, p. 705.)

ANISOCERAS, *sp.*

(Pl. XV., Figs. 2, 2*a*.)

Observations.—A fragment, truncated obliquely at each end, and having an average length of 27 mm., probably belongs to this genus. It is almost straight, and bears rounded ribs, 1·5 mm. wide, separated by grooves of about the same width, that pass almost straight across the shell, and are equally prominent all round the shell, except perhaps on the centre of the slightly convex curve of the shell, where they appear to be a little less so. The transverse section of the shell is elliptical, its diameters being 15 and 12 mm. respectively. At one end the siphuncle is visible, showing that the region on which the ribs are more slightly marked is the ventral. The specimen may be compared with *Anisoceras indicum*, Forbes, sp.,* and *Anisoceras subcompressum*, Forbes, sp.,† being more elliptical in transverse section than the former, and having the ribs closer together and more rounded than in the latter. Both forms, according to Stoliczka, occur in both the Valudayur and the Utatúr Groups in Southern India. Kossmat, however, refers the Utatúr forms doubtfully to these species. Under the name *Anisoceras rugatum*, Griesbach‡ records *Anisoceras indicum*

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* E. Forbes, Trans. Geol. Soc. London, 2nd ser., vii., 1846, Pt. 3, p. 116 (not the figures, Pl. xi., f. 4*a*, *b*, *c*). For other references and synonymy see F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 1 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. ix., Heft iii. and iv.), 1895, p. 49 (145).

† E. Forbes, Trans. Geol. Soc. London, 2nd ser., vii., 1846, Pt. 3, p. 116, Pl. xi., f. 6*a*, *b*, *c*. For other references and synonymy see F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 1 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. ix., Heft iii and iv.), 1895, p. 49 (145).

‡ C. L. Griesbach, Quart. Journ. Geol. Soc., xxvii., 1871, p. 63, Pl. iii., f. 4.

from the Umtamvuna (or Umzamba) beds (bed *d*), at the Umtamvuna River, the southern limit of Natal; and Woods has identified both *Anisoceras subcompressum* * and *Anisoc. indicum* † in the Cretaceous rocks of Pondoland.

5. Genus Baculites, *Lamarck.*

(Mém. Soc. d'hist. nat., 1799, p. 80.)

Baculites, *sp.*

Observations.—All the examples of this genus in the collection are contained in one small block; they include two or three fragments, and an impression of the outer surface of a shell. The exserted portion of the largest example is only about 31 mm. long; it is an internal cast, exhibiting no septa and therefore probably a portion of the body-chamber; its transverse section is oval, slightly flattened at the antisiphonal surface; the dorso-ventral and transverse diameters at its anterior end are 18 and 12 mm. respectively; it bears a row of obliquely-placed tubercles, situated nearer the antisiphonal than the siphonal surface, and appears also to have had a shallow longitudinal groove at about the middle of the lateral area.

Another example, 40 mm. long, is part of a smaller shell, and is almost entirely embedded in matrix; it has a similar transverse section, the dorso-ventral and transverse diameters at the anterior and posterior ends being 15 and 10 mm., and 14 and 9·5 mm. respectively, so that the shell was evidently a slowly-tapering one.

The impression is that of the lateral area of a shell of about the same size as the smaller example just mentioned; its ornaments consist of a longitudinal row of nodes rather obliquely-placed and nearer the antisiphonal than the siphonal area; also with riblets which bend rapidly backward from the siphonal margin until they reach the row of tubercles, dorsad of which they curve round and pass forward on to the antisiphonal surface, which they cross in a very feeble orad-convex curve.

These specimens seem to be related to *B. capensis*, H. Woods,‡ but the tubercles appear to be much closer and more oblique than in that species.

6. Genus Schlœnbachia, *Neumayr.*

(Sitzungsber. d. k. Akad. Wissensch., math.-naturw. Cl., Bd. lxxi., Abth. i., 1875, p. 658; and Zeitschr. Deutsch. geol. Gesell., Bd. xxvii., 1875, p. 887.)

Schlœnbachia, *sp.*

Observations.—There are a few fragments, and impressions of

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* H. Woods, Ann. S. African Museum, iv., Pt. vii., 1906, p. 339, Pl. xliii., f. 2*a*, 2*b*.

† *Ibid.*, p. 340, Pl. xliv., f. 2*a*, 2*b*.

‡ *Ibid.*, p. 342, Pl. xliv., f. 6, 7.

the whorls, of a large, acutely-ribbed species of *Schlœnbachia*,* but they are much too imperfect for specific determination.

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7. Genus Acanthoceras, *Neumayr*.

(Zeitschr. Deutsch. geol. Gesell., Bd. xxvii., 1875, p. 929.)

Acanthoceras, *sp.*

Observations.—This genus is represented by a fragment of an outer whorl, measuring 180 mm. along the centre of the periphery, with a portion of the penultimate whorl attached. The outer whorl exhibits no septa and seems to have formed part of the body-chamber; when complete it was probably rather more than 160 mm. in diameter, and the umbilicus about 60 mm. wide. The whorl is quadrangular in transverse section, much wider than high; at the anterior end the dorso-ventral and transverse diameters are 56 and 76 (excluding the ribs) mm. respectively. The lateral area is ornamented with strong, straight ribs, seven in a length of 160 mm., a little backwardly-inclined in passing outward from the umbilical margin, and raised into a compressed tubercle at this margin and into a somewhat larger one at the outer boundary of the lateral area. The periphery is flattened; the ribs are here very much less prominent, but broader, than on the sides, and are slightly swollen both in the median line and at a short distance on each side of this line, indicating the presence of three rows of peripheral tubercles at an earlier stage.

Of the species described in the present report this specimen may be compared with *Acanth. latum* † and *Acanth. quadratum.*‡ Compared with the former, this fossil is a less rapidly-expanding shell, has the ribs on the lateral area much narrower and more acute, the tubercles in the outer row transversely- instead of longitudinally-elongated, whilst on the periphery the ribs are more pronounced and the attendant tubercles more obscure; compared with the latter the ribs are more distant and are more prominent between the tubercles, the tubercles in the outer row transversely-elongated, the periphery relatively broader, and the ribs here more distinct.

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8. Genus Desmoceras, *Zittel emend. Grossouvre*.

(Recherches sur la craie supérieure, Pt. 2, Paléontologie, Les Ammonites de la craie supérieure, 1893, p. 166.)

Desmoceras, *sp.*

(Pl. XV., Figs. 3, 3*a*.)

Observations.—A specimen in the Manuan Creek collection

* Using the name in a wide sense and not as restricted by either De Grossouvre (Amm. craie supér., 1893, p. 109) or Hyatt (in Eastman's Transl. of Zittel's Text-book of Palaeontology, 1900, p. 589). † See *antea*, p. 195. ‡ See *antea*, p. 192.

agrees very well with the specimen which Stoliczka described and figured (Cret. Fauna, S. India, i., Cephalopoda, p. 120, Pl. lix. f. 12, 12*a*, 12*b*) under the name of *Ammonites Yama*, Forbes,* but which he subsequently referred† to *Ammonites diphylloides*, Forbes.‡ Dr. Kossmat,§ however, does not regard the fossil as belonging to Forbes' species, but considers it to be a new species allied to *Desmoceras inane*, Stoliczka, sp. Mr. Anderson's example has the following dimensions:—diameter of shell, 36·5 mm. (1); height of outer whorl, 18·5 mm. (0·50); thickness of outer whorl, 19 mm. (0·52); width of umbilicus, 5 mm. (0·13). It is an internal cast of apparently nearly the whole of the septate part of a shell, there being on the outer surface of the first part of the last whorl indications of only three septa in front of the septal surface at the anterior end of the specimen. Its greatest thickness is at about the middle of the lateral area. Portions of the suture-lines are present, but the surface of the fossil has been so weathered that they can be only with great difficulty detected here and there. The septal surface at the anterior end of the fossil, however, shows that between the ventral lobe and the umbilical shoulder there were five lobes and (counting the external saddle) six saddles, gradually decreasing in size from the periphery towards the umbilicus. The umbilical zone is narrow, convex, and almost perpendicular to the mesal plane of the shell.

The Indian forms occur in the Utatúr Group in the Trichinopoli district.

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9. Genus Hauericeras, *A. de Grossouvre.*

(Recherches sur la craie supérieure, Pt. 2, Paléontologie, Les Ammonites de la craie supérieure, 1893, p. 221.)

Hauericeras, *sp.*

(Pl. XV., Figs. 5, 5*a*.)

Observations.—This genus, a sub-genus of *Puzosia* according to Kossmat,‖ appears to be represented by the half of an individual, measuring along the fractured edges 38 mm. It is part of a much compressed shell, almost entirely devoid of the test, the internal cast bearing obscure traces of faint, feebly-sigmoidal striæ. At its greatest diameter its other dimensions are:—Height of outer whorl, 17 mm. (0·45, assuming the diameter = 1); thickness of outer whorl, 8 mm. (0·21); width of umbilicus, 9·5 mm. (0·25). The sides are much flattened;

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* E. Forbes, Trans. Geol. Soc. London, 2nd ser., vii., Pt. 3, 1846, p. 107, Pl. vii., f. 4*a*, *b*.

† F. Stoliczka, Records Geol. Surv. India, i., 1868, p. 34.

‡ E. Forbes, *op. cit.*, p. 105, Pl. viii., f. 8*a*, *b*, *c*.

§ F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 3 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. xi., Heft iii.), 1898, p. 173 (108). See also *antea*, p. 212.

‖ *Ibid.*, pp. 171 (106) and 187 (122).

the umbilical zone narrow, convex, and nearly perpendicular to the mesal plane of the shell; the ventral area is narrowly-convex, but cannot be said to possess a keel; there are no traces of the suture-lines, and no indications of sulci on the lateral area. Compared with the two species of this genus that have been recorded from Pondoland, *Hauericeras Gardeni*, Baily, sp.,* and *Hauericeras Rembda*, Forbes, sp.,† the present species is a more compressed, more rapidly-increasing and less widely umbilicated shell than the former, the narrow umbilicus distinguishing it from the latter and also all the known species of the genus. All the species of the genus are confined to the Senonian.

HAUERICERAS, *sp.*

Observations.—To this genus may probably be referred a piece of a compressed, umbilicated shell with smooth whorls. The specimen, measured along the periphery, is about 100 mm. long; its transverse section is compressed-elliptical in outline, about two-thirds as wide as high, the anterior end of the whorl being approximately 40 mm. high and 25 mm. wide. The periphery is not well preserved, and, judging from the posterior end of the specimen, may have been rounded, as in *Puzosia*, and without a keel. There are, however, no signs of sculpture on the peripheral portion of the lateral area, as is usual in that genus. It is, therefore, with some doubt referred to the present genus.

B. NAUTILOIDEA.

GENUS NAUTILUS, *Linn.* (*ex Breyn*), *restricted.*

(Syst. Nat., 1758, Ed. X., p. 708.)

NAUTILUS MANUANENSIS, *sp. nov.*

(Pl. XV., Figs. 6, 6*a*.)

Description.—Shell robust, inflated, umbilicated; greatest thickness at the umbilical margin, about two-thirds of the diameter of the shell; height of outer whorl about two-thirds of the diameter of the shell. Whorls few (? exact number); inclusion nearly complete; umbilicus deep, infundibuliform, exposing a small portion of the inner whorls, about one-fourteenth or fifteenth of the diameter of the shell wide at the bottom, but at its margin about three-sixteenths of the diameter of the shell wide, with sub-angular margin, and sides sloping

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* W. H. Baily, Quart. Journ. Geol. Soc., xi. (1855), p. 456, Pl. xi., f. 3*a*, *b*, *c*. See also F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 3 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. xi., Heft iii.), 1897, p. 188 (123), Pl. xxiv. (xviii.), f. 7*a*, 7*b*, 8, 10; and H. Woods, Ann. S. African Museum, iv., Pt. vii., 1906, p. 332.

† E. Forbes, Trans. Geol. Soc. London, 2nd ser., vii., Pt. 3, 1846, p. 111, Pl. vii., f. 3. See also F. Kossmat, *op. cit.*, p. 189 (124), Pl. xxiv. (xviii.), f. 9; and H. Woods, *op. cit.*, p. 333.

steeply towards the centre of the umbilicus. Whorl semi-elliptical in cross-section, about as wide as high, indented to about one-third of its height by the preceding whorl; periphery broadly convex, a little flattened; sides feebly convex, flattened; umbilical zone fairly well marked off from the lateral area by a sub-angular margin, convex, sloping steeply towards the centre of the umbilicus. Body-chamber apparently occupying about half a whorl; aperture not seen. Chambers shallow, about eleven in the last half-whorl; septa only slightly curved; suture-line with a shallow curve on the periphery and one on the lateral area, the umbilical portion of the line curved backward. Siphuncle dorsocentren. Test covered with very strong, regular, flattened ribs, which form a feebly sigmoid curve on the sides of the shell and a rather deep broad sinus on the periphery; the ribs bifurcate, and even trifurcate, in some places on the sides of the shell where they are relatively broader than on the periphery; the interspaces dividing them are on the periphery about one-half the width of the ribs themselves. The ribs are only faintly shown on the internal cast.

Dimensions.

Diameter of shell	about	160 mm.
Height of outer whorl	,,	107 mm.
Ditto above preceding whorl ...	,,	70 mm.
Thickness of outer whorl	,,	110 mm.
Width of umbilicus at bottom ...	,,	11 mm.
Ditto at margin	,,	29 mm.

Observations.—This species is numerously represented in Mr. Anderson's collection from the Manuan Creek, but most of the specimens are much weathered and very imperfect. The dimensions given above are taken from the best-preserved example, but only a portion of the body-chamber is present, and the peripheral portion of this is incomplete.

It is a less tumid, more finely ornamented, and more narrowly-umbilicated shell than *Nautilus pseudo-elegans*, d'Orbigny.*

The species is referable to Hyatt's genus *Cymatoceras*.†

NAUTILUS, *sp.*

Observations.— Hyatt's genus *Cymatoceras* is also represented by several examples of another large species which, in external characters, differs from *N. manuanensis* chiefly in having flatter sides and a more broadly-rounded periphery.

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* A. d'Orbigny, Pal. Franç., Terr. Crét., i., 1840, p. 70, Pl. viii. and ix. See also A. H. Foord, Cat. Foss. Ceph., British Museum (Nat. Hist.), Pt. 2, 1891, p. 255, f. 59*a*, *b*.

† A. Hyatt, Genera of Fossil Cephalopoda, Proc. Boston Soc. Nat. Hist., xxii., Pt. 3, Jan., 1884, p. 301.

NAUTILUS, *sp.*

Observations.—Another species is indicated in the collection by several more or less imperfect examples, which have a comparatively smooth shell, and are probably referable to Hyatt's genus *Entrephoceras.**

(*b*) MIDDLE TRIBUTARY OF THE MANUAN CREEK, ZULULAND.

This little collection includes five small fossils, viz., one Nautilus and four Ammonites, but only two specimens, both Ammonites, are in a good state of preservation.

A. AMMONOIDEA.

1. GENUS PUZOSIA, *Bayle.*

(Explication de la carte géologique de la France, t. iv., Atlas, 1878, Pls. xlv. and xlvi.)

PUZOSIA CONCINNA, *sp. nov.*

Observations.—The collection labelled "Crossing Middle Tribu-"tary, Manuan Creek," contains a fairly good example, having the following dimensions:—Diameter of shell, 31·5 mm. (1); height of outer whorl, 12 mm. (0·38); thickness of outer whorl, 10 mm. (0·32); width of umbilicus, 10 mm. (0·32). The specimen is entirely septate and bears evidence on its outer whorl of the septate part having extended over fully another two-thirds of a whorl. Each whorl bears five very slightly sigmoidally-curved sulci, projected forwards at the periphery, in the median line of which each forms a narrow tongue-shaped projection. The test on the periphery and on the peripheral portion of the lateral area of the whorl, nearly to the line of involution, bears fine ribs, which curve strongly forwards at the periphery, whilst the test on the rest of the lateral area is smooth. The inclusion is fully one-half. Only the dorsal portion of the suture-line is shown; this is preserved on the outer surface of the last whorl, and seems to have been the dorsal portion of the last septum.

In general form and dimensions this specimen comes nearest *Puzosia Bhima*, Stoliczka, sp.,† from the Utatúr Group (Lower *fide* Kossmat ‡) of the Trichinopoli district of Southern India, but if belonging to that species it must have been quite a young shell. Stoliczka described his species as possessing 7–8 transverse furrows on each whorl, whereas the Manuan Creek example possesses only five on each whorl, and further does not display the fine striæ on the

* A. Hyatt, Phylogeny of an Acquired Characteristic, Proc. Amer. Philos. Soc., xxxii., No. 143, Appendix, p. 555, 1894.

† F. Stoliczka, Cret. Fauna S. India (Pal. Ind.), i., p. 137, Pl. lxix., f. 1–3.

‡ F. Kossmat, Untersuchungen über die südindische Kreideformation, Pt. 3 (Beitr. zur Paläont. u. Geol. Österr.-Ungarns, &c., Bd. xi., Heft iii.), 1898, p. 184 (119).

lateral area mentioned by Stoliczka in his species. *Puzosia Mayoriana*, d'Orbigny, sp.,* is readily distinguishable from the Zululand form by the sigmoidal, almost falciform, curvature of its constrictions and the different curvature of the riblets on the outer portion of the lateral area and on the periphery; it is, moreover, a slightly more inflated shell.

Puzosia compacta, *sp. nov.*

(Pl. XV., Figs. 7, 7*a*.)

Description.—Shell rather small, discoidal, umbilicated; greatest thickness at about one-third of the width of the lateral area from the edge of the umbilicus, about two-fifths of the diameter; height of outer whorl about two-fifths of the diameter of the shell. Whorls few (? exact number); inclusion about one-half; umbilicus rather deep, with step-like walls which are nearly perpendicular to the mesal plane of the shell, about two-sevenths of the diameter of the shell in width. Whorl oval in transverse section, about as wide as high; indented to nearly one-third of its height by the preceding whorl; periphery rather narrowly convex, not defined from the lateral area; sides feebly convex, having their greatest convexity a little nearer the umbilicus than the periphery; umbilical zone not sharply defined from the lateral area, convex, narrow, sloping steeply towards the centre of the umbilicus, nearly perpendicular to the mesal plane of the shell. Length of body-chamber and aperture not seen. Chambers not very deep; suture-line only imperfectly seen: ventral lobe narrow; external saddle narrow, its anterior portion divided by a small secondary lobe into two nearly equal parts, almost entirely confined to the periphery; first lateral lobe narrow, not so wide as the external saddle, a little longer than the ventral lobe, trifid; first lateral saddle about as high as the external saddle, situated at about the middle of the lateral area. Test smooth, each whorl with five or six feebly sigmoidal forwardly-directed constrictions, which bend rather sharply forward before passing on to the periphery; they are deepest at the umbilical margin, and more distinct on the cast than on the test.

Dimensions.

Diameter of shell	...	21·0 mm. (1)
Height of outer whorl	...	8·5 mm. (0·40)
Thickness of outer whorl	...	8·5 mm. (0·40)
Width of umbilicus	...	6·5 mm. (0·31)

Observations.—This species is represented by a single moderately good specimen, bearing the test on the inner whorls and on a great part of the outer whorl, the denuded places on the outer whorl exhibiting portions of the suture-line. By its small umbilicus and greater inflation this species is readily distinguished from the other form of the same genus from this locality.

* A. d'Orbigny, Pal. Franç., Terr. Crét., i., 1840, p. 267, Pl. lxxix., f. 1–3.

2. Genus Schlœnbachia, *Neumayr.*

(Sitzungsber. d. k. Akad. Wissensch., math.-naturw. Cl., Wien, Bd. lxxi., Abth. i., 1875, p. 658; and Zeitschr. Deutsch. geol. Gesell., Bd. xxvii., 1875, p. 887.)

Schlœnbachia, *sp.*

Observations.—To this genus * belongs a coarsely-ribbed, badly preserved fossil, having approximately the following dimensions: Diameter of shell, 13 mm. (1); height of outer whorl, 5·5 mm. (0·42); thickness of outer whorl, including the ribs, 9 mm. (0·69); width of umbilicus 5 mm. (0·38). The shell expands rapidly; the periphery is broadly-flattened, and has a median keel. The ribs are strong, prominent, fairly acute and with a slight orad-concave curve on the sides; they turn abruptly forward at the edge of the periphery, are considerably thickened on the periphery, and disappear at the side of the median keel. There are about twenty in the outer whorl.

The fossil seems to be comparable with such forms as d'Orbigny's *Ammonites Delaruei*† and Pictet's *Ammonites cornutus*,‡ but the former species has relatively finer ribs in the young, and each rib in the adult is prolonged outwards into a distinct spine; whilst the latter species is smooth in the young and the ribs do not attain the coarseness of those of the Zululand fossil before the remarkable prominences so characteristic of the shell are developed. Of the forms described from Southern India, the only shell at all comparable with the present one appears to be Stoliczka's *Ammonites corruptus*,§ a rare shell occurring in the Utatúr Group in the Trichinopoli district, but that shell expands laterally less rapidly than the Zululand form, and each rib was provided near the umbilicus with a prominent tubercle, which seems to be wanting in the present specimen. The Zululand fossil, is, however, in such a bad state of preservation that accurate comparison with other forms is impossible. It bears some resemblance to the species which White ‖ described from the Cretaceous of Brazil as *Ammonites tectorius*, a species which Lemoine ¶ has recorded from the north of Madagascar.

In Eastman's translation of Zittel's "Text-book of Palaeontology," 1900, Professor Hyatt (p. 589) proposed the new generic name *Dipoloceras*, giving as the genotype *Ammonites cristatus*, d'Orbigny,** and it is possible that the present fossil from Zululand is referable to this genus.

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* Using the name in a wide sense; see footnote, *antea*, p. 241.

† A. d'Orbigny, Pal. Franç., Terr. Crét., i., 1840, p. 296, Pl. lxxxvii., f. 6–8.

‡ F. J. Pictet, in Pictet and Roux, Descrip. Moll. Foss. Grès verts, 1847, p. 93, Pl. viii., f. 6*a–c*.

§ F. Stoliczka, Cret. Fauna S. India (Pal. Indica), i., Cephalopoda, p. 58, Pl. xxxvi., f. 2, 2*a*, 2*b*, 2*c*.

‖ C. A. White, Contrib. Paléont. Brazil (Archiv. Mus. Nac. Rio de Janeiro, vii., 1887), p. 225, Pl. xx., f. 6, 7.

¶ P. Lemoine, Études géologiques dans le nord de Madagascar, 1906, p. 206.

** The species is really Deluc's, and in the legend to the figure of the species in the "Text-book of Palaeontology" (f. 1234) the species is attributed to that author.

3. Genus Hysteroceras, *Hyatt.*

(In Eastman's translation of Zittel's "Text-book of Palaeontology, 1900, p. 590.)

Hysteroceras, *sp.*

(Pl. XV., Figs. 8, 8*a*.)

Observations.—A fragment measuring 32 mm. along the centre of the periphery, and forming part of a whorl about 24 mm. in diameter, with a small portion of the next inner whorl attached, seems to be closely allied to such forms as *Ammonites varicosus*, J. de C. Sowerby,* and *Ammonites Senequieri*, d'Orbigny,† although it does not perfectly agree with either of these species. At the anterior end the transverse section of the whorl is semi-elliptical, 8 mm. high and 7·5 mm. wide. The ribs are alternately long and short, each is thickened near the periphery, and each longer one is elevated, almost tuberculated, at the margin of the umbilicus. Passing from the periphery to the umbilicus, the ribs are directed slightly backwards. There is scarcely any keel; only a very slight connection between adjacent ribs. In this respect the specimen approaches closely to *Amm. Senequieri*, d'Orbigny, but in that species the ribs are of equal strength, whereas in the Zululand fossil the ribs are alternately longer and shorter, as in *Amm. varicosus*, J. de C. Sowerby, the longer ones being almost tuberculated, as in that species also. In *Amm. varicosus*, however, in a whorl having the same diameter as that of the Zululand fossil there is a distinct keel along the centre of the periphery, the peripheral ends of the thickened ribs turn forward very slightly at the side of the keel, whilst the lateral portion of the ribs have a nearly radial direction.

On the whole, the fossil may perhaps be regarded as nearer to Sowerby's *Amm. varicosus* than to d'Orbigny's *Amm. Senequieri*, but both occur in the Albian of France, the former also in the Albian of England.

In Eastman's translation of Zittel's "Text-book of Palaeontology," 1900, p. 590, Professor Hyatt proposed the generic name *Hysteroceras*, giving as the genotype *Ammonites varicosus*, d'Orbigny ;‡ and on the same page of the same work instituted the genus *Hystatoceras*, the genotype being *Ammonites Senequeiri*, d'Orbigny.

The Zululand fossil may therefore be regarded as *Hysteroceras, sp.*

B. NAUTILOIDEA.

Genus Nautilus, *Linn.* (*ex Breyn*), *restricted.*

(Syst. Nat., 1758, Ed. X., p. 708.)

Nautilus, *sp.*

Observations.—The genus *Nautilus* is represented by a small frag-

* J. de C. Sowerby, Min. Conch., v., p. 74, 1824, Pl. ccccli., f. [? 4], 5.

† A. d'Orbigny, Pal. Franç., Terr. crét., i., 1840, p. 292, Pl. lxxxvi., f. 3–5.

‡ The species was, however, first described by J. de C. Sowerby, Min. Conch., v., p. 74, 1824, Pl. ccccli., f. [? 4], 5.

ment consisting of the internal cast of two chambers and of part of a third of a rather small shell. The septal surface at the front of the specimen is 26 mm. wide, its greatest width is at a short distance from the umbilicus, the septal surface at the front of the specimen being 26 mm. wide and rather more than 13 mm. high in the mesal plane. Viewed posteriorly the siphuncle is rather nearer the dorsal than the ventral surface, but viewed anteriorly the siphuncle appears to have been as nearly as possible central or even a little nearer the ventral than the dorsal surface. There is a very distinct annular lobe. The chambers are not very deep; the suture-line is simply curved. The specimen bears some resemblance to *Nautilus Bouchardianus*, d'Orbigny,* but it is too imperfect for an exact specific determination.

III.—GEOLOGICAL RESULTS.

The fossils from the Manuan Creek, being as a rule fragmentary and very imperfectly preserved, do not admit of the precise identification possible with the False Bay specimens; they belong, however, to the same series of beds as the False Bay fossils, but most of them—*i.e.*, those labelled "South Branch of the Manuan Creek"—most probably represent a somewhat higher horizon (possibly Senonian) than that indicated by those fossils, whilst the few specimens from the "Middle Tributary of the Manuan Creek" seem to show the existence there of either a lower portion of the beds which are exposed at False Bay, or even a slightly lower horizon.

LIST OF CEPHALOPODA FROM THE MANUAN CREEK, ZULULAND.

(*a*) South Branch.

	PAGE		PAGE
Phylloceras, sp.	236	Acanthoceras, sp.	241
Lytoceras crenulatum, *G. C. Crick*	236	Desmoceras, sp.	241
Gaudryceras pulchrum, *G. C. Crick*	237	Hauericeras, sp.	242
Gaudryceras, sp.	238	Hauericeras, sp.	243
Gaudryceras, sp.	239	Nautilus manuanensis, *G. C. Crick*	243
Anisoceras, sp.	239	Nautilus, sp.	244
Baculites, sp.	240	Nautilus, sp.	245
Schlœnbachia, sp.	240		

(*b*) Middle Tributary.

	PAGE		PAGE
Puzosia concinna, *G. C. Crick* ...	245	Hysteroceras, sp.	248
Puzosia compacta, *G. C. Crick* ...	246	Nautilus, sp.	249
Schlœnbachia, sp.	247		

* A. d'Orbigny, Pal. Franç., Terr. crét., i., 1840, p. 75, Pl. xiii., f. 1–2.

III.—NOTE ON A CRETACEOUS AMMONITE FROM THE MOUTH OF THE UMPENYATI RIVER, NATAL.

A small Ammonite, found in association with the fish teeth (described by Dr. A. S. Woodward in the present Report) at the mouth of the Umpenyati River on the south-east coast of Natal, is referable to *Ammonites umbulazi*, described by Baily * from the Umtamvuna beds,† near the mouth of the Umtamvuna River at the southern boundary of Natal. The fossil is detached from matrix. The ventral portion of the last third of the outer whorl is missing. The dimensions of the specimen can therefore be best taken where the diameter of the fossil is 20 mm. (1); here the other dimensions are: Height of whorl, 10·5 mm. (0·52); thickness of whorl, 5 mm. (0·25); width of umbilicus, 4 mm. (0·2).

Kossmat ‡ regards this species as belonging to the narrowly-umbilicated forms of *Schlœnbachia* (*Prionocyclus*); Solger § refers it with a query to *Muniericeras;* and Woods || refers it simply to *Schlœnbachia.* The species seems to belong to the group of *Amm. varians*, to which group De Grossouvre,¶ in 1893, proposed to restrict Neumayr's genus *Schlœnbachia*, selecting as the genotype *Amm. varians*, J. Sowerby. Subsequently, in 1900, Hyatt ** also restricted Neumayr's genus, taking as the genotype *Amm. Germari*, Reuss, and proposed a new genus *Hystrichoceras*, with *Amm. Coupei*, Brongn., as the genotype, including in it Sowerby's *Amm. varians.* The Natal form is, therefore, here referred to the genus *Schlœnbachia*, Neumayr emend. Grossouvre (*non* Hyatt), of which Hyatt's genus *Hystrichoceras* is a synonym.

Griesbach†† recorded the existence of the Umtamvuna (or Umzamba) beds at the mouth of the Umpenyati River. The various opinions which have been entertained respecting the age of these beds have been recently dealt with by Mr. Woods‡‡ in his description of the Cretaceous Fauna of Pondoland; he regards the whole of these beds as of Campanian (Upper Senonian) age.

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* W. H. Baily, Quart. Journ. Geol. Soc., xi., 1855, p. 456, Pl. xi., figs. 4*a*, *b*, *c*. The name of this species is spelt *umbolazi* by Griesbach.

† Called also the Umzamba beds. See Ann. Rep. Geol. Commis. Cape of Good Hope, 1901 [1902], pp. 38 *et seqq.*; and A. W. Rogers, Geology of Cape Colony, 1905, p. 318.

‡ F. Kossmat, Jahrb. d. k.k. geolog. Reichsanst., Wien, Bd. xliv., 1894, p. 464; and Records Geol. Survey India, xxviii., Pt. 2, 1895, p. 43.

§ F. Solger, in Beiträge zur Geologie von Kamerun, by Dr. E. Esch, Dr. F. Solger, Dr. M. Oppenheim, and Professor Dr. O. Jaekel, 1904, p. 205.

|| H. Woods, Ann. S. African Museum, iv., Pt. vii., 1906, p. 336.

¶ A. de Grossouvre, Recherches sur la craie supérieure, Pt. 2, Paléontologie, Les Ammonites de la craie supérieure, 1893, pp. 107, 109.

** A. Hyatt, in Eastman's translation of Zittel's "Text-book of Palaeontology," i., 1900, p. 589.

†† C. L. Griesbach, Quart. Journ. Geol. Soc., xxvii., 1871, p. 53.

‡‡ H. Woods, *op. cit*, pp. 344 *et seqq.*

A COLLECTION OF FOSSIL MAMMALS

FROM

THE COAST OF ZULULAND.

By WILLIAM B. SCOTT,

Princeton University, U.S.A.

A COLLECTION OF FOSSIL MAMMALS FROM THE COAST OF ZULULAND.

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Hitherto almost no remains of Tertiary mammals have been reported from South Africa, and therefore unusual interest attaches to a small collection of such remains gathered by Mr. Anderson on the coast of Zululand, and by him sent to the writer for determination.

Concerning the position and mode of occurrence of these fossils Mr. Anderson writes as follows: "The fossils were scattered over a" "large flat outcrop of shales, which occurs below the level of ordinary" "low-water mark, and is only exposed under the exceptional circum-" "stances of a strong south-easterly gale and a neap tide, when the" "large covering of sand is removed. Overlying this bed are a series" "of shales with a few scattered bones and crustacean and fish" "remains. Above these a thin layer containing Foraminifera, and" "then a foot or so containing marine Mollusca, which Mr. Etheridge" "referred to the Tertiary period; above this a thick series (probably" "over 100 feet) of false bedded sands of various colours covered by" "the Recent sand dunes."

Though described as a shale in the foregoing account, the matrix still adhering to the bones appears rather to be a friable, unconsolidated, and somewhat granular mud, containing little clay and a very large quantity of fine sand, coloured dark brown by vegetable matter.

The teeth appear to have been very completely mineralised by the substitution of silica for the original materials; on the other hand, the bones are much less completely changed, while both bones and teeth are heavy and very dark in colour.

The list of species represented in the collection is short, not more than six or seven, but they appear all to be extinct, though all are referable to living genera, and most of them are nearly allied to existing species. The type of fauna indicated by the list, short as it is, is characteristically South African; in addition to more or less fragmentary remains of fishes, turtles, and a very large crocodile, it includes a hippopotamus, buffalo, two antelopes, a rhinoceros, and an elephant. The species are thus all of hoofed animals, and no representatives of the Carnivora or Rodentia or of other small mammals are included. A strange lack is the absence of the horses, of which not a

fragment has been detected, though the number of species is so small that no importance can be attached to this fact.

Seeing that these mammals all belong to existing genera, and that, with the exception of the elephant, they differ but comparatively little from Recent Ethiopian species, it is obvious that the fossils cannot have any very great geological antiquity, and probably they should be referred to the later Pliocene. So far, however, as the mammals themselves are concerned, they might almost equally well be regarded as early Pleistocene. Unfortunately they give us little information concerning the origin of the modern South African fauna, or the former relations of the region to other continents.

ARTIODACTYLA.

HIPPOPOTAMUS.

Remains of this genus are the most numerous objects in the collection, and of one individual a considerable part of the skeleton is represented. This specimen comprises several thoracic, lumbar, and sacral vertebræ, and a number of ribs, the pelvis entire, fragments of several bones of the fore and hind limbs and part of the carpus. All of these agree closely with the corresponding parts of the recent *H. amphibius* in size and characteristics, and may very well have belonged to that species. A number of isolated teeth, however, indicate a species nearly allied to, but different from the modern one. Unfortunately there is no method at present of determining whether the bones and teeth belong to the same species, and thus it remains uncertain whether the collection contains one species of Hippopotamus or two.

HIPPOPOTAMUS PONDEROSUS, *sp. nov.*

(Plate XVI., Figs. 1-3.)

As the type of this species I have selected an isolated third lower molar of the left side; the other teeth in the collection, which are less characteristic, may or may not have belonged to the same animal. This does not apply to a very much worn first lower molar, which evidently belonged to an older individual.

The third lower molar (M. $\bar{3}$) is very large, being but slightly inferior in antero-posterior length to the corresponding tooth of the largest skull of *H. amphibius*, with which I have been able to compare it, and in proportion to that length is somewhat narrower. The tooth was evidently freshly erupted, and shows but slight sign of abrasion. In construction this tooth differs in several respects from that of the modern species, though the differences are not of sufficient importance to require a generic separation. As in *H. amphibius*, the four main cusps of the crown are arranged in two transverse pairs, but the two cusps of each pair are divided from each other by a deeper fissure.

The posterior, unpaired lobe, or heel, has a more median, less internal position, and is very much higher than is usual in the existing species. In the latter the heel varies very much in development, but I have seen no specimen in which it is so high as in the fossil. Further, in the fossil the heel is separated from the posterior pair of cusps by a much more profound cleft, while the oblique, tuberculated ridge, connecting the heel with the postero-internal cusp, is but feebly indicated, and much less prominent than in *H. amphibius*. As in the modern species, an external cusp is imperfectly separated from the heel, but is much higher and more distinct than in *H. amphibius*. On the posterior face of the heel is a groove, not present in the modern species, which appears like an incipient additional internal cusp. The cingulum is distinctly indicated on the anterior and posterior faces of the crown; posteriorly it is hardly so thick or prominent as in the existing species, but on the anterior face it is far higher than in the latter, rising for more than half the height of the anterior pair of cusps.

Two isolated lower premolars, contained in the collection, so resemble the type-specimen in appearance, mode of preservation, and degree of abrasion, that they might very well have been derived from the same individual. If so, however, they are relatively somewhat smaller than in the recent species.

The first tooth (P. $\bar{2}$ of the original series) is rather smaller and more slender than in *H. amphibius*, from which it further differs in the presence of a small tubercle on the inner side of the principal cusp (protoconid), and in the much more prominent cingulum, which completely encircles the crown, and is especially strong on the internal, anterior, and posterior faces.

The second premolar (P. $\bar{3}$) differs from that of *H. amphibius* in the more prominent cingulum, in the absence of a posterior basal tubercle, and in the presence of a sort of buttress on each of the outer and inner sides of the principal cusp (protoconid), demarcated by shallow grooves.

In the subjoined table the measurements of the teeth of *H. amphibius* are taken from the unusually large individual mentioned above. All the measurements are in the metric system.

Measurements.

	H. amph.	*H. pond.*
Third lower molar (M. $\bar{3}$), length (ant.-post. diam.)...	·0775	·076
„ „ „ width (transv. diam.)	·0425	·0375
„ „ „ height of heel	·037	·048
First lower premolar (P. $\bar{2}$), length.....	·035	·032
Second lower premolar (P. $\bar{3}$), length.....	·046	·037

The skeletal remains are not sufficiently characteristic for description.

BUBALUS, *Frisch.*

The Buffalo is represented by an incomplete right ramus mandibuli, which retains the second and third molars and the alveoli of the other cheek-teeth, but lacking the symphysial region, condyle, coro-

noid, and angle. Several cervical vertebræ, in a more or less fragmentary condition, doubtless are referable to the same species, though probably not to the same individual. The animal is nearly allied to the existing *B. caffer*, but differs sufficiently in tooth-pattern to require its reference to a distinct species.

BUBALUS ANDERSONI, *sp. nov.*

(Plate XVI., Figs. 4, 4*a*.)

The type of this species is the mandible, with second and third molars, which is mentioned above. The jaw indicates an animal which is rather larger and more robust than *B. caffer*, judging from the specimens of the latter with which I have had an opportunity to compare it.

The second and third lower molars are somewhat more elongate antero-posteriorly and narrower transversely than in the existing species, and the enamel wall bounding the valleys externally is more simple and less sinuous. The third molar (M. $\bar{3}$) is quite distinctly different from that of *B. caffer;* the enamel loop, or pillar, between the two external crescents, which in the modern species is present in M. $\bar{1}$ and M. $\bar{2}$, but not in M. $\bar{3}$, is very prominently developed, while the fifth lobe, or heel, is much narrower and more compressed laterally, and contains no enamel lake. Probably in the unworn tooth a valley was present in the heel, but, if so, it must have been shallower than in *B. caffer*, and disappears at an earlier stage of wear. The heel is connected with the body of the tooth by a much narrower and more constricted neck, the cement-filled valley between the heel and the postero-external crescent being much wider and deeper.

The horizontal ramus of the lower jaw is somewhat shallower dorso-ventrally than in the modern species, but is very thick and solid. This species is named in honour of W. Anderson, Esq., Government Geologist of Natal.

Measurements.

	B. caffer.	*B. andersoni.*
Premolar-molar series, length	·146	·170
Second lower molar, length	·028	·032
„ „ „ width	·0185	·018
Third lower molar, length	·040	·045
„ „ „ width	·018	·0185
„ „ „ „ of heel	·0125	·011
Mandible, depth below M. $\bar{3}$	·072	·069
„ thickness below M. $\bar{3}$	·032	·0315

ANTILOPIDÆ INCERTÆ SEDIS.

(Plate XVII., Figs. 1, 2.)

Two different genera of antelopes are indicated by two different fragmentary specimens. These I have not been able to determine, partly because of the very unsatisfactory condition of the material, and

partly because the number of recent South African antelopes available for comparison has been limited.

One of the fossils is the posterior portion of the third lower molar of the left side, comprising the posterior pair of crescents and the heel, and belonging to quite a large animal. The crown is quite thick and covered with cement, while the enamel, where exposed by the removal of the cement, is seen to be thick, rugose, and much wrinkled on the surface. The talon is very large and of subtriangular shape, flattened on the inner, convex on the outer side. Among recent South African antelopes with which I have had an opportunity to compare this tooth, the closest resemblance is to *Connochætes*, though the fossil is larger and at least specifically different from any of the modern species.

The second specimen is a fragment of the left half of the lower jaw, with the first and second molars in place. The teeth have been so much abraded by water-rolling in sand and gravel that no identification can be made. This is a much smaller animal than the preceding one, and may have been one of the Gazelles, of which *Antidorcas* is the one most like the fossil. An apparent abnormality is the presence of a deep, cylindrical hole in the enamel of the external crescents of each tooth. In addition M. 1 is in an evidently diseased condition.

PERISSODACTYLA.

OPSICEROS, *Gloger* (ATELODUS, *Pomel*).

The African Rhinoceroses are usually referred to the genus (or subgenus) *Atelodus* of Pomel, but, as Thomas has shown (1895), the latter name is long antedated by the term *Opsiceros* of Gloger, which should therefore be employed.

In the collection the Rhinoceroses are represented by five loose teeth, all of the upper jaw, and derived from at least two individuals. There is considerable reason to believe that two species, both allied to the recent *O. bicornis*, are represented by these teeth, but it would be premature to recognise more than one until more complete and satisfactory material has been obtained.

OPSICEROS SIMPLICIDENS, *sp. nov.*

(Plate XVII., Figs. 3-5.)

The type of this species is a second upper molar, evidently derived from quite a young animal, as it is not at all abraded, and is unfortunately incomplete at the base, so that its full transverse width cannot be determined. The tooth is very similar to M. 2 of *O. bicornis* in a corresponding state of development, but displays a number of differences, which are clearly of specific value.

1. The tooth indicates a larger animal than the average of *O. bicornis*.

2. It is more elongate antero-posteriorly, and strikingly narrower and more compressed laterally.

3. In correspondence with this difference in shape the anterior crest (protoloph) is shorter and much more strongly recurved, while the posterior crest (metaloph) is directed more backward, less inward; it meets the outer wall at a very acute angle, and thus makes the posterior valley of a different shape from that of the recent species and much narrower.

4. The outer wall of the crown projects little, if at all, behind the postero-internal cusp (hypocone).

5. The crista is better developed and fuses with the anticrotchet, so as to enclose a small and apparently shallow fossette.

6. The antero-external cusp is larger, and the rib at the junction with the postero-external is much more prominent, while the whole outer surface of the crown is made more undulating by the prominence of this rib and by the presence of a low, broad convexity, somewhat behind the middle of the outer wall.

Measurements.

Second upper molar, length	·062
„ „ „ approximate width	·044

The other teeth, which are provisionally referred to this species, are much abraded, and evidently were derived from an old individual. In part their different appearance is due to this abrasion, but this would not account for the great difference in transverse width. Making all due allowance for the fact that the type specimen is incomplete at the base, it remains true that M. $\underline{2}$ is very narrow and M. $\underline{1}$ is very much broader, much more so than seems likely to occur in one and the same species. However, it would be unwise to establish another species upon the basis of such worn and uncharacteristic teeth as those before us.

The first upper molar has none of the lateral compression which distinguishes the type, but, on the contrary, is subquadrate and very broad, the width exceeding the antero-posterior length. The tooth-pattern is very simple, the only accessory structure being a low, rounded projection, which arises from the junction of the posterior crest with the outer wall, and thus has a different position from the anticrotchet of *O. bicornis*. The posterior valley has been isolated by wear into an enamel lake, and the cingulum is prominent on the anterior, posterior, and internal faces of the crown. Except for the position of the anticrotchet, this tooth very closely resembles M. $\underline{1}$ of *O. bicornis* in a corresponding stage of wear.

The fourth upper premolar is also much like that of old specimens of the existing species. The tooth is large and subquadrate, though the width decidedly exceeds the antero-posterior length. The external wall is simply convex, and a prominent cingulum surrounds the inner half of the crown; the grinding surface is extremely simple, the only complication being a faintly indicated anticrotchet. In mode-

rately worn teeth of *O. bicornis* P. $\frac{4}{4}$ has a double anticrotchet and a minute crista, but in at least some old individuals these features have disappeared, and the tooth is worn to a pattern very similar to the individual before us.

Measurements.

Fourth upper premolar, length	·0456
" " " width	·054
First upper molar, length	·060
" " " width	·067

PROBOSCIDEA.

ELEPHAS (LOXODON), *L.*

The most interesting and significant specimens in the collection are two very well preserved elephant's teeth, which, though not in absolutely the same state of abrasion, are yet probably the right and left third lower molars of the same individual, the difference in the amount of wear being not so great as may often be observed between the two sides of the same jaw.

ELEPHAS (LOXODON) ZULU, *sp. nov.*

(Plate XVII., Fig. 6; Plate XVIII.)

In view of the notoriously difficult task of determining the species of elephants from isolated teeth, it will serve a useful purpose to introduce the description of these Zululand specimens by a translation of Pohlig's general remarks upon this question.

"*General Crown-forms.*—These must be regarded as at least as" "important, perhaps in some cases more important, a criterion for the" "systematic division of the Proboscidea as the number of lamellæ." "The general distinctions in the crown-forms of the low-crowned" "*E. meridionalis*, *E. planifrons*, from the high-crowned *E. indicus*," "*E. primigenius*, and especially *E. antiquus*, *E. namadicus*, and" "*E. africanus*, are well known; the former may be contrasted, as" "*Tapinodiscal* elephants, with the latter, or *Hypselodiscal*. . . . Like-" "wise Falconer emphasised the distinction between the narrow and" "broad crowned forms as a specific character; to the former, which" "may be termed *Angusticoronate*, belong *E. africanus*, *E. antiquus*," "and *E. namadicus*, while to the *Laticoronate* forms belong the" "Tapinodiscal and the remainder of the Hypselodiscal species." "A further difference consists in the greater or less thickness of the" "enamel plates; as *Pachyganal* teeth may be instanced the Tapino-" "discal forms, and, in general, most of the Hypselodiscal species also," "with the exception of the Mammoth, which is especially *Endioganal*."

"L. Adams has pointed out that the last-mentioned characters" "are not always constant in the same species. . . .

"Fr. Cuvier's separation of *E. africanus*, as the subgenus" "Loxodon with rhombic lamellar pattern, from *E. indicus* as the" "typical representative of the genus Elephas *sensu stricto*, was ex-"

[illegible] Fischer [illegible] besides *E. primigenius* and *E. trogontherii*, also *E. guadarrensis* and *E. meridionalis* as well as the *E. meridionalis* and *E. planifrons* Falc. all other forms. In his classification Fischer has evidently laid too much stress upon the number of lamellæ while he did not sufficiently value other essential characters. Thus typical molars of *E. meridionalis* have nothing in common with those of *E. primigenius* except the small number of lamellæ while the former species is far removed from the latter in the form of the crown and in the pattern of the lamellæ. Estimating all the essential relations of the teeth at their value we reach the following phylogenetic division of the elephants in the broader sense:—

I. Loxodontoidea. Type *E. meridionalis*. Transition to the following group formed by *E. guadarrensis*. Trigonodiscal, bilophodont and trilophodont molars. Partly lamellate. Mostly only 13 lamellæ in M. 3.

IIa. Loxodontoidea. Type: *E. africanus* and *E. priscus*. Transition to the following group formed by *E. antiquus*. Hypselodiscal, bilophodont molars.

IIb. Proboscidea. Type: *E. primigenius*. Transitions to the preceding group in *E. indicus* and *E. namadicus*. Hypselodiscal, laterodontate, bilophodont molars. Densilamellate. Mostly more than 20 lamellæ in M. 3." (Pohlig, 1888, pp. 135–138.)

The most obvious object of comparison with *E. celtensis* is *E. africanus*, and it will therefore be useful to quote certain of Pohlig's remarks upon the latter species. "Among all normally developed elephants *E. africanus* has relatively the smallest molars and also the minimal number of lamellæ: the maximum, which is rarely attained, is x11x" (x13x? according to Leith Adams). . . . The small size of the cheek-teeth, especially in proportion to the gigantic size attained by *E. africanus*, considerably surpassing that of *E. indicus*, is one of the most noteworthy peculiarities of the species. In addition should be mentioned the extreme loxodontism, which is approximated by *E. antiquus* only in individual cases, and the narrow form of the crowns. . . . The small size, in general, and especially the narrowness of the recent elephants' molars, in comparison with those of all the fossil species (even *E. antiquus* included) should be particularly noted; molars of *E. indicus* or *E. africanus* of more than ·086 m. width are not known, even in the most gigantic skulls" (Pohlig, 1888, pp. 242–243).

Turning now to the examination of the fossil teeth, one is immediately struck by the fact that they represent a very similar type to those of *E.* (*L.*) *africanus*, yet differing in such a way as immediately

[illegible] This means 11 fully formed plates with a talon-like, partially formed lamella at each end of the tooth.

to suggest the more ancient elephants of India and Europe, such as *E. planifrons*, *E. meridionalis*, *E. antiquus*, and *E. priscus* (Pohlig, *non* Goldfuss). Indeed, this tooth might almost be described as intermediate in character between Pohlig's two groups, the *Archidiscodonta* and the *Loxodonta*. The third lower molar is very large, almost equalling in size that of the most gigantic modern African elephants, and in shape is elongate and rather narrow, though broader relatively than in *E. africanus*, so much so as to verge upon the laticoronate type. It will be observed from the table of measurements that while the breadth of crown equals the maximum recorded, even of the upper molars, for any individual of the existing African or Indian species, the length is considerably less than in these exceptionally gigantic individuals. The degree of abrasion is such that the height of the crown can be only estimated, but, judging from the posterior, unworn portion, this dimension was less than in *E. africanus*, though probably not sufficiently so to deserve the name Tapinodiscal. This is a distinguishing feature from *E. planifrons* and *E. meridionalis*. The tooth has a strong antero-posterior curvature, with the concavity turned outward and the convexity inward.

In the anterior part of the tooth abrasion has progressed so far as completely to remove all traces of the talon and several laminæ, and thus the ridge formula cannot be determined with certainty. It is plain, however, that the number of ridges, not including the talons, cannot have been less than 12, and may have been 13. There is some doubt as to the maximum number of laminæ which occurs in *E. africanus*. Adams (1877, p. 35) says: "I can find no record nor" "discover any ultimate molar of *E. africanus* with a larger ridge formula" "than x13x; indeed, in far the greatest number of specimens it seldom" "exceeds x11x." Pohlig, on the other hand, questions this (1888, p. 242), and says: "The maximum, which is rarely attained, is x11x." It thus appears probable that in *E. zulu* the number of ridges was normally greater than in *E. africanus*, as might be inferred from the narrower shape of the laminæ themselves.

More significant than the number of the ridges is their shape, and one is immediately struck by the fact that in the fossil the pattern is decidedly less loxodont than in the recent African species; the median expansion of each lamina is less, and hence the successive ridges are more widely separated, while in the less abraded ridges the loxodont pattern is not displayed at all, the two enamel walls of each lamina being quite parallel. The enamel is very thick (pachyganal) and very strongly crimped. The lateral terminations of the laminæ are either rounded or trifoliate, and each ridge has a feebly curved or crescentic shape, with the horns directed forward. The three posterior ridges have only the points of the digitations exposed, and of these there are four to each ridge, and those of successive plates are arranged in longitudinal rows in a manner suggestive of *E. meridionalis*.

In several respects these teeth of *E. zulu* resemble the curious molars of *E. antiquus*, which were originally described by Falconer as *E. priscus*: "The discs of wear present an unmistakable resemblance"

" to those of the existing African elephant, in breadth, lozenge-shaped "
" outline and mesial expansion, but when examined in detail, there are "
" obvious points of distinction. In the living species the lozenges are "
" more distinctly rhomb-shaped; the salient edge of enamel is distinctly "
" crimped; the lateral terminations of the rhombs are flattened; and the "
" mesial angles of the contiguous discs are either more approximated or "
" overlap each other laterally. In *E.* (*Loxodon*) *priscus* the discs are "
" rounded at their lateral terminations and broader. Although the "
" mesial expansion is quite as great as in the African elephant, it is less "
" sudden, and in the general outline there is a tendency to a reniform or "
" obsolete crescentic shape, the anterior enamel boundary of each disc "
" being concave and the posterior convex" (1868, vol. ii., p. 97, pl. viii., figs. 3, 4).

In *E. zulu* the lozenge pattern is less distinct than in these exceptional teeth of *E. antiquus*, and the enamel is even more crimped and thicker than in *E. africanus*, but there is a strong resemblance to both species.

Measurements.

Third lower molar, length	·265
„ „ „ width	·085
„ „ „ height of posterior portion	·081

From a single pair of teeth it would be a hazardous undertaking to determine the phylogenetic significance of *E. zulu*, yet, so far as the evidence reaches, it gives us no reason to suppose that this species was not the direct ancestor of *E. africanus*. In most discussions concerning the descent of the various species of elephants it is usually taken for granted that evolutionary progress in molar structure has always been by the addition of plates or discs. In many, perhaps most, cases this is probably true, but it is not necessarily true of all. The example of certain phyla, such as the Rodents, shows us that, within the limits of a single family, dental evolution may proceed, now by increased complication and number of elements, now by simplification and reduction of elements already present.

Should *E. zulu* eventually prove to be the actual ancestor of *E. africanus*, it would tend to give the latter a less isolated position, connecting it with Asiatic and European species. At all events, it is extremely interesting and important to find in South Africa an elephant with so many points of resemblance to species characteristic of the northern hemisphere.

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EXPLANATION

OF

PLATES.

Unless otherwise stated, the figures in Plates I.-VI. and X.-XV. represent the specimens of the natural size.

PLATE I.

SERPULA PINCHINIANA, *var.* UMSINENENSIS, *Eth. fil.*

FIG. 1.—A mass of aggregated tubes, feebly connected together.
2.—A single tube, nearly straight.
3.—A portion of the surface of Fig. 2 magnified to show the concentrically roughened exterior.
4.—Tubes seen in section displaying in places the two layers, the outer not always continuous round the inner.
5.—Tube almost forming a semicircle—x 2.
6.—Tube slightly curved, showing the full diameter attained by this species.

TRIGONIA VENTRICOSA, *Krauss, sp.*

7.—Left valve, showing the oblique thick costæ, gradually enlarging ventrally, the anterior crenulated in the umbonal region.
8.—The same valve, exhibiting the oblique crenulated ridges of the posterior slope.

MYOPSIS (?) AFRICANA, *Eth. fil.*

9.—Partly exfoliated left valve.
10.—Radiating lines of granules ornamenting the test—magnified.

AXINŒA SUBAURICULATA, *Forbes* (?) *sp.*

11.—Imperfect valve with delicate linear costæ and fine concentric lines.
12.—Internal cast with toothed ventral margin.

GERVILLIA DENTATA, *Krauss, sp.*

13.—Imperfect shell, partly exfoliated, partly an internal cast.
14.—Dorsal margin of Fig. 13, with three deep and wide-apart resilifers.
15.—Transverse section showing thickness of the test.

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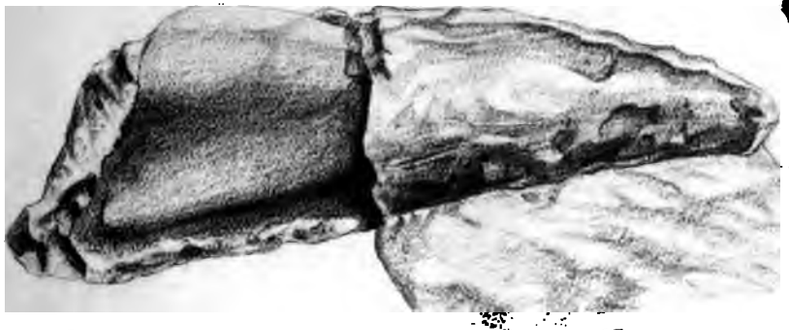

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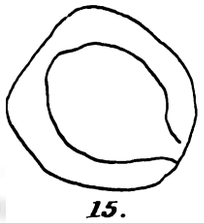

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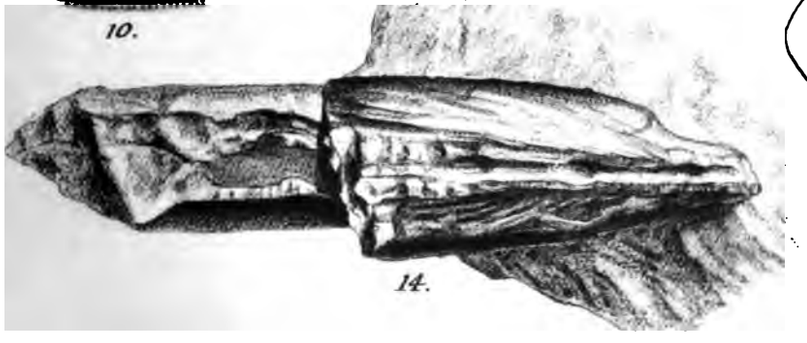

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PLATE II.

INOCERAMUS VOLVIUMBONATUS, *Eth. fil.*

FIG 1.—Left valve of a mature shell, with high prominent umbonal region and strong concentric ridges.
2.—Another similar left valve.
3.—Smaller valve seen from the anterior, displaying the inrolled umbo and finer concentric ridges.
4.—A left valve displaying portions of three resilifers.
5.—A younger left valve with the sharp outstanding distant concentric ridges characteristic of the young state.
6.—Fig. 5 seen from the anterior, with its inrolled umbo.

OSTREA, *sp.*

7.—Flat, exfoliated, rather geniculate valve, seen from the interior; the adductor scar is visible.

PSEUDAVICULA (?) AFRICANA, *Eth. fil.*

8.—Exfoliated left valve, with remains of simple radiating costæ—x 2.
9.—Internal cast of a left valve, with portion of the adductor scar visible.
10.—A small left valve similar to Fig. 8.
11.—Another small left valve similar to Fig. 8—x 2.

ENTOLIUM ANDERSONI, *Eth. fil.*

12.—Suborbicular and lenticular compressed valve, with small flat triangular auricles.

HEMIASTER (?), *sp.*

13.—An irregular Euechinid, possibly referable to this genus—x 2.
14.—Section of the shell taken at the broken anterior end.

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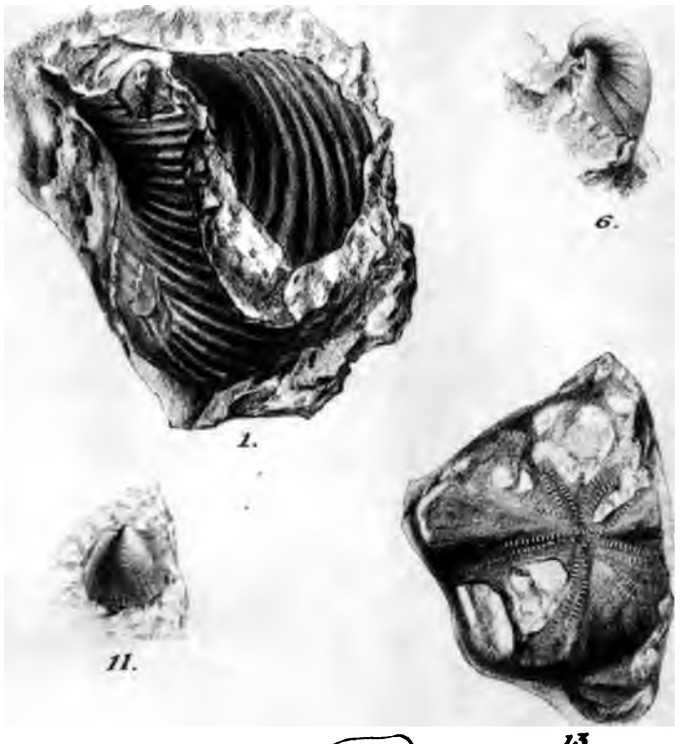

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PLATE III.

VENIELLA (?) SANCTÆ-LUCIENSIS, *Eth. fil.*

FIG. 1.—A mutilated right valve.

2.—A more or less perfect right valve, exhibiting a steep posterior slope, obliquely truncate posterior end, and bold sculpture.

CUCULLÆA (?) UMSINENENSIS, *Eth. fil.*

3.—Left valve seen from directly in front, exhibiting the high umbonal region,

4.—The same valve somewhat canted backwards, showing the obesity of the same portion.

4A.—The posterior slope, displaying the median obtuse fold and insinuated margin.

CYTHEREA (?), *sp.*

5.—Partially preserved left valve.

PROTOCARDIUM (?) CINCTUTUM, *Eth. fil.*

6.—Right valve partly testaceous, partly an internal cast, the edge of the posterior slope indicated by a raised thread and groove.

7.—The thread reposing in its groove referred to under Fig. 6, enlarged.

ASTARTE HERTZOGI, *Krauss.*

8.—Testaceous right valve.

GLYCIMERIS (?) GRIESBACHI, *Eth. fil.*

9.—Partially preserved right valve.

PLEUROMYA (?), *sp.*

10.—Partially preserved right valve.

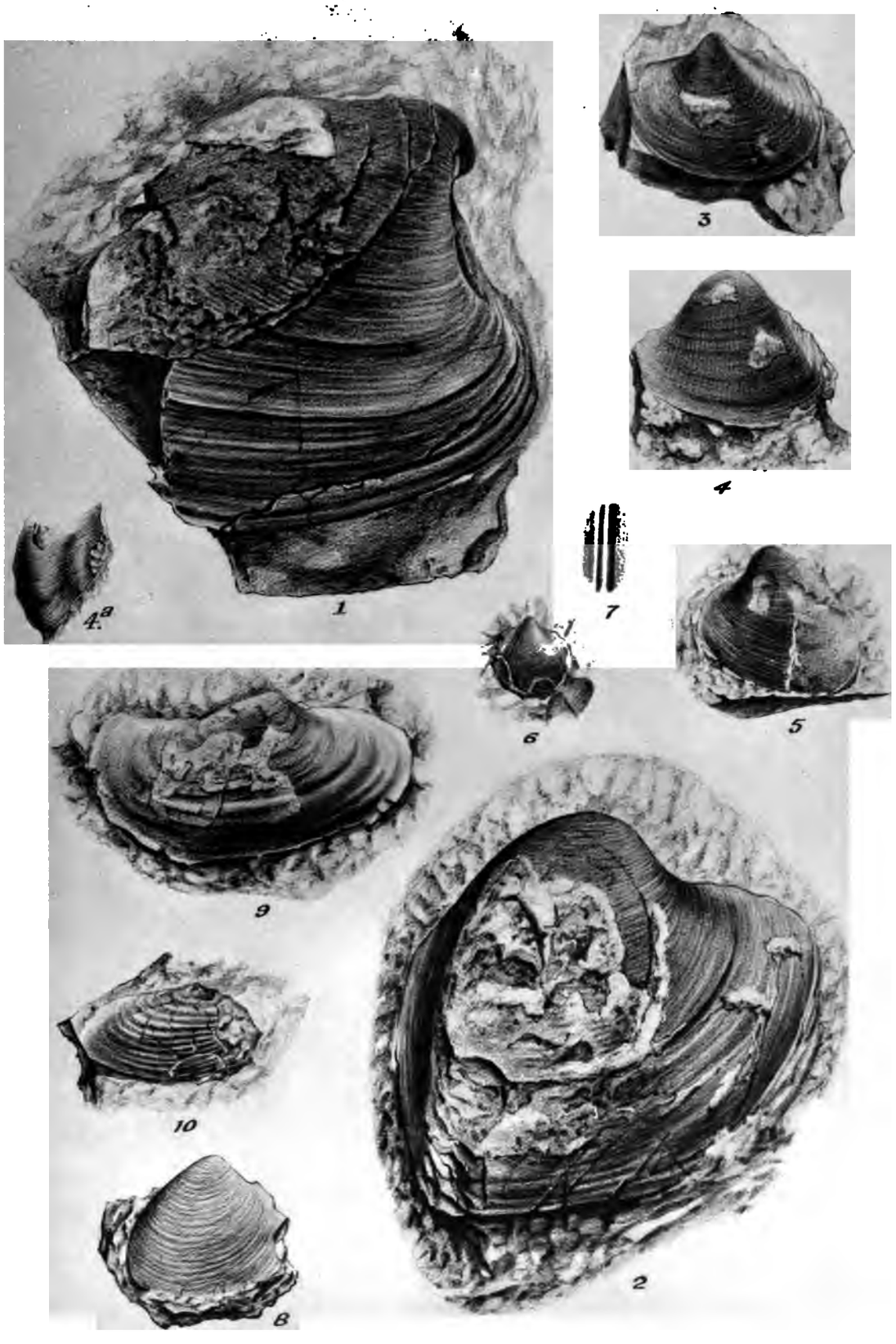

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PLATE IV.

DOUVILLEICERAS (?) NODOSA, *Eth. fil.*

FIG. 1. Side view of portion of an exfoliated whorl, displaying the obtuse costæ, and rows of longitudinally elongated tubercles.

2.—Ventral view of the same specimen (Fig. 1), again exhibiting the obtuse costæ, broad venter, and the tubercles.

PSEUDAMAURA TERRAZULENSIS, *Eth. fil.*

3.—A partly testaceous, partly internal cast. On the body whorl the portion of test retained displays the sculpture.

4.—A similar specimen, exhibiting a portion of the aperture, with the reflected and channelled inner lip.

5.—The sculpture of the test of Fig. 3, enlarged.

PARAPHOLAS TATEI, *Eth. fil.*

6.—Portion of matrix with an imperfect valve (*a*).

7.—The portion of valve (Fig. 6A), showing the umbonal oblique cincture, and anterior to it a still more oblique anterior cincture—x 2.

7A.—The umbonal cincture, consisting of a transversely crenulated groove and rib, enlarged.

NEITHEA QUINQUECOSTATA, *J. Sowerby.*

8.—Convex valve seen from the front—x 2.

9.—The same valve (Fig. 8) seen from the side—x 2.

TRIGONIA, *sp.*

10.—Imperfect internal cast of a left valve.

ACTÆON, *sp.*

11.—Body whorl and imperfect aperture seen from the front. On the inner lip there appears to be the remains of a tooth—x 2.

12.—The sculpture of Fig. 11, enlarged.

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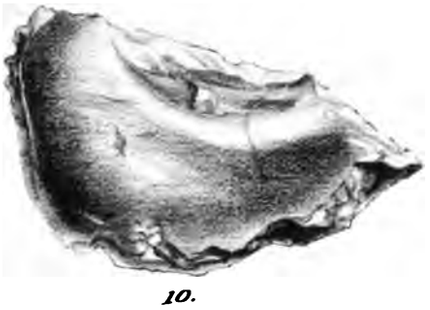

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PLATE V.

DOUVILLEICERAS, *sp.*

FIG. 1.—Portion of a whorl, side view, with similar but more numerous costæ than in Plate IV., Figs. 1 and 2, and very many more rows of longitudinally elongated tubercles.

2.—Ventral view of the same specimen (Fig. 1).

HAMITES (?), *sp.*

3.—Portion of a whorl, apparently uncoiled, with sharp, outstanding, distant costæ, that may possibly belong to this genus.

ZARIA (?), *sp.*

4.—A broken shell, *minus* the apical and lower whorls—x 2.

5.—A portion of Fig. 4 enlarged to show the sculpture.

PSEUDAMAURA TERRAZULENSIS, *Eth. fil.*

6.—An exfoliated example with the spire rather more perfectly preserved than in Plate IV., Fig. 3.

7.—The three upper whorls of Fig. 6, showing the sculpture—x 2.

8.—Another example in which the sculpture is visible over nearly the entire body whorl.

ALARIA (?) BAILYI, *Eth. fil.*

9.—A young shell of six whorls; the first two are devoid of sculpture, the third, fourth, and fifth are both costate and spirally lined, and the sixth is exfoliate—x 3.

SOLARIUM HEDLEYI, *Eth. fil.*

10.—Side view—x 2.

11.—Base of Fig. 10, displaying a portion of the umbilicus and basal sculpture —x 2.

12.—Sculpture of the body whorl taken from the upper surface of Fig. 11, enlarged.

TEREDO (?) IN WOOD.

13.—Tubes penetrating wood.

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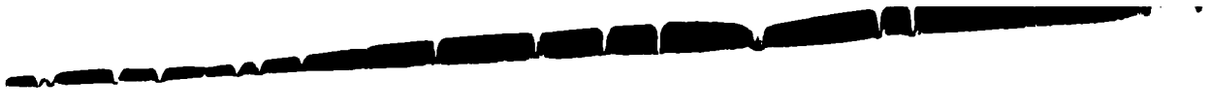

PLATE VI.

DESMOCERAS, *sp.*

Portion of a large exfoliated shell with indications of slightly sigmoidal costæ and two varicial constrictions.

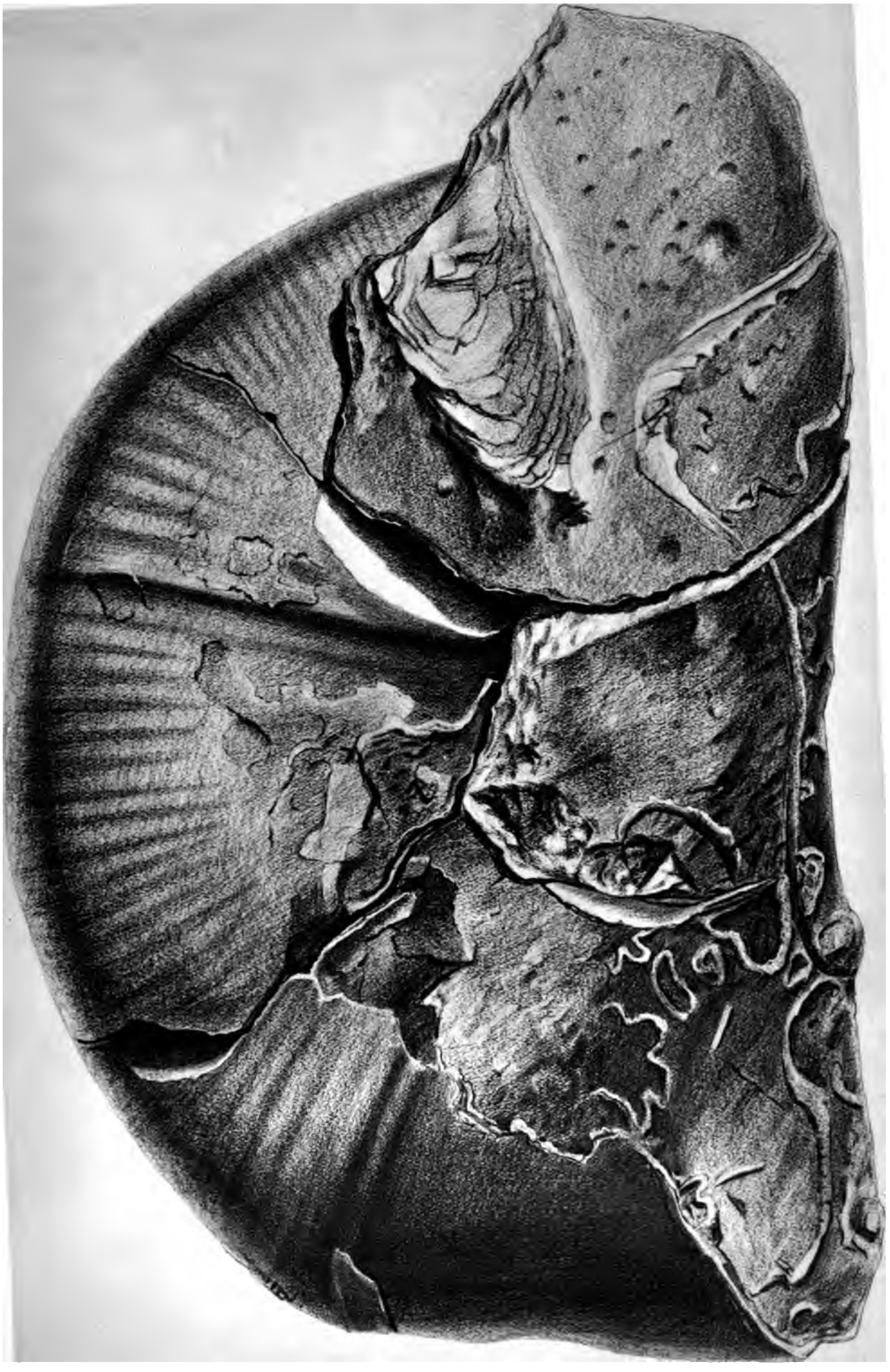

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PLATE VII.

Section of Tertiary Beds, containing mammalian remains, with overlying strata, Zululand Coast.

PLATE VII.

SUR. OF NATAL.

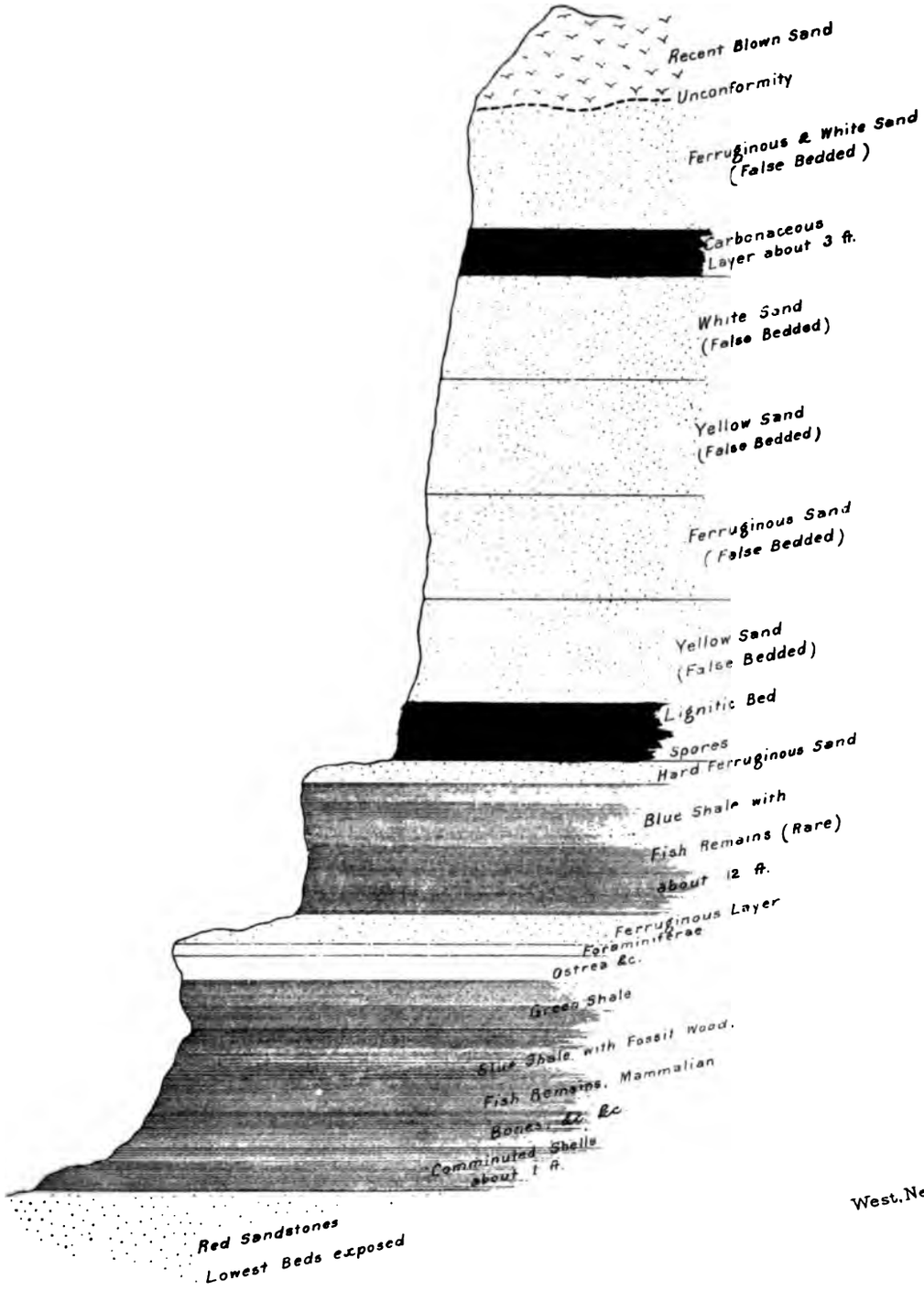

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PLATE VIII.

Rock painting from Bushman Cave-shelters, slopes of the Drakensberg, Underberg district.

(I am indebted for the photographs of Plates VIII. and IX. to Mr. Laffan's Assistant, Pietermaritzburg.)

FIG. 1.

West, Newman ph. proc.

FIG. 2.

PLATE IX.

Rock paintings from Bushman Cave-shelters, slopes of the Drakensberg, Underberg district.

FIG. 1.—This is evidently a painting of much more recent date than the others. Near the top an undoubted figure of a European type of horse is depicted; while below are representations of canoes or boats, with one native in each. In the first boat on the right, the native is evidently using a pole for the purposes of progression.

2.—Above the hindquarters of the buck the indistinct representation of a Zebra or Quagga is depicted, although it may be a Buffalo or Gnu.

FIG. 1.

West, Newman ph. proc.

FIG. 2.

PLATE X.

NOTE.—For explanation of Figs. 1–9 inclusive, see Dr. Smith Woodward's description of the Fish remains. (See page 99.)

PHYLLOCERAS VELLEDÆ, *Stol. sp.* (? MICHELIN *sp.*) (p. 166).

FIG. 10.—Lateral aspect of a small septate example, showing the ornaments.

10A.—Front view of the same specimen.

11.—Side view of a fragment of the natural cast of a larger shell, showing the fine ribs on the periphery, and at the anterior end a portion of the septal surface.

11A.—Peripheral view of the same specimen, showing the fine ribs on the periphery.

PHYLLOCERAS *cf.* ELLIPTICUM, *Kossmat* (p. 169).

12.—Lateral aspect of half an individual.

12A.—Front view of the same specimen, showing the greater part of the septal surface, and the form of the cross-section of the inner whorls.

GAUDRYCERAS *aff.* SACYA, *Forbes sp.* (p. 170).

13.—Lateral aspect of portion of natural internal cast, the dotted line indicating the form of the complete shell.

13A.—Front view of fractured surface of the same example; the obliquity of the truncation of the whorls in the upper part of the figure causes the height of these whorls to appear much too small.

GAUDRYCERAS ODIENSE, *Kossmat* (p. 171).

14.—Lateral aspect of a completely septate example.

14A.—Front view of same specimen.

TETRAGONITES TIMOTHEANUS, *Stol. sp.* (? *Mayor sp.*) (p. 172).

15.—Lateral aspect of well-preserved specimen, showing constrictions on the outer whorl.

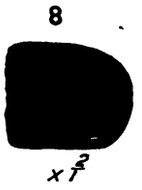
15A.—Front view of same example, showing form of septal surface.

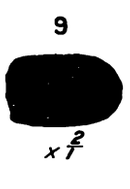
KNEMOCERAS (?) CORNUTUM, *G. C. Crick* (p. 179).

16.—Lateral aspect of fragment.

16A.—Front view of the same.

16B.—Peripheral aspect of the same.





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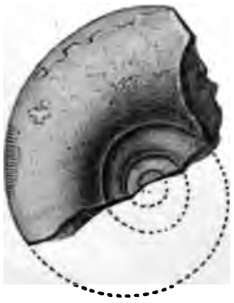
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PLATE XI.

TURRILITES SCHEUCHZERIANUS, *Bosc* (p. 173).

FIG. 1.—Lateral aspect, showing the slight interruption of the ribs on the earlier whorls.

1A.—Basal aspect of the same example.

TURRILITES COSTATUS, *Lamarck* (p. 174).

2.—Lateral aspect of imperfect example.

TURRILITES ACUTUS, *Passy* (p. 176).

3.—Lateral aspect of well-preserved example, with apical angle of medium size.

3A.—Basal view of the same specimen.

4.—Lateral aspect of example, exhibiting the greatest apical angle (41°) and the greatest diameter of whorl.

4A.—Basal aspect of the same example.

TURRILITES NODIFERUS, *G. C. Crick* (p. 177).

5.—Lateral aspect of type-specimen.

5A.—Basal aspect of the same example.

FORBESICERAS LARGILLIERTIANUM, *d'Orbigny sp.* (p. 180).

6.—Lateral aspect of fragment, showing sculpture and, at the left-hand side of the figure, the edge of the small umbilicus.

6A.—Peripheral aspect of same specimen.

FORBESICERAS SCULPTUM, *G. C. Crick* (p. 182).

7.—Lateral aspect of the type-specimen.

7A.—Peripheral aspect of the same.

FORBESICERAS NODOSUM, *G. C. Crick* (p. 182).

8.—Lateral aspect of type-specimen, showing ornaments and, at the left-hand side of the figure below the fracture, the edge of the small umbilicus, × ⅔.

8A.—View of posterior end of same example.

8B.—Portion of periphery of posterior part of same example, showing subdivision of ribs into two.

8C.—Part of periphery of anterior portion of same example, showing subdivision of ribs into three.

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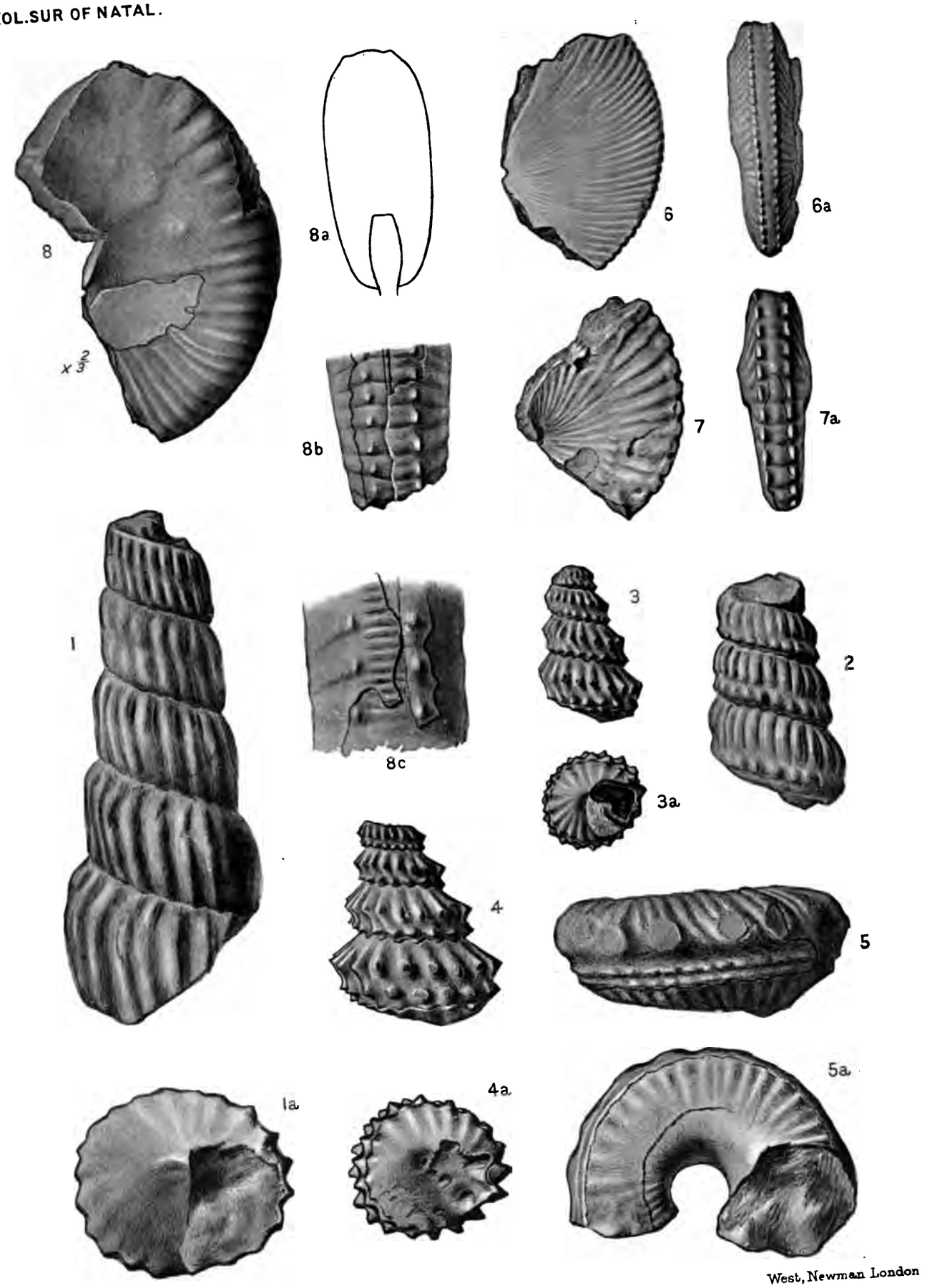

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PLATE XII.

ACANTHOCERAS FLEXUOSUM, *G. C. Crick* (p. 184).

FIG. 1.—Lateral aspect of type-specimen.

1A.—Front view of same example, showing form of septal surface. The median portion of the periphery of the earliest portion of the outer whorl is broken so as to show the siphuncle.

ACANTHOCERAS LATUM, *G. C. Crick* (p. 195).

2.—Lateral aspect of type-specimen, × ⅔.

2A.—Peripheral aspect of the same, × ⅔.

ACANTHOCERAS NEWBOLDI, *var.* SPINOSA, *Kossmat* (p. 199).

3.—Lateral aspect of completely septate example. The specimen is not quite symmetrical, the portion of the lateral area on the left-hand side of the figure being pushed a little towards the umbilicus so that the tubercles near the umbilical margin project over the umbilicus, their normal position being more nearly as shown at the anterior end of the specimen.

3A.—Peripheral view of the same example; the median row of tubercles is only just visible.

ACANTHOCERAS NITIDUM, *G. C. Crick* (p. 201).

4.—Lateral aspect of the type-specimen.

4A.—Peripheral view of the same.

ACANTHOCERAS CHOFFATI, *Kossmat* (p. 205).

5.—Lateral aspect of specimen (*b*), showing flexure of the ribs.

5A.—Peripheral view of the same, showing disappearance of the median row of tubercles.

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PLATE XII.

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PLATE XIII.

ACANTHOCERAS CORNIGERUM, *G. C. Crick* (p. 207).

FIG. 1.—Lateral aspect of the type-specimen.

1A.—Front view of the same example; the asymmetry of the fossil is shown at the bottom of the right-hand side of the figure.

ACANTHOCERAS QUADRATUM, *G. C. Crick* (p. 192).

2.—Lateral aspect of the type-specimen; it is completely septate, and there are traces of the dorsal portions of the septa in front of the anterior end of the fossil as far as the sixth rib.

2A.—Peripheral view of same; the groove in the centre of the periphery is produced by the laying open of the siphuncle.

ACANTHOCERAS PAUCINODATUM, *G. C. Crick* (p. 203).

3.—Lateral aspect of type-specimen.

3A.—Front view of same example.

ACANTHOCERAS HIPPOCASTANUM, *J. de C. Sowerby sp.* (p. 194).

4.—Lateral aspect of specimen.

4A.—Peripheral aspect of the same example.

TETRAGONITES TIMOTHEANUS, *Stol. sp.* (? *Mayor sp.*) (p. 172).

5.—Lateral aspect of much weathered septate specimen, with traces of some of the suture-lines.

5A.—Front view of the same example.

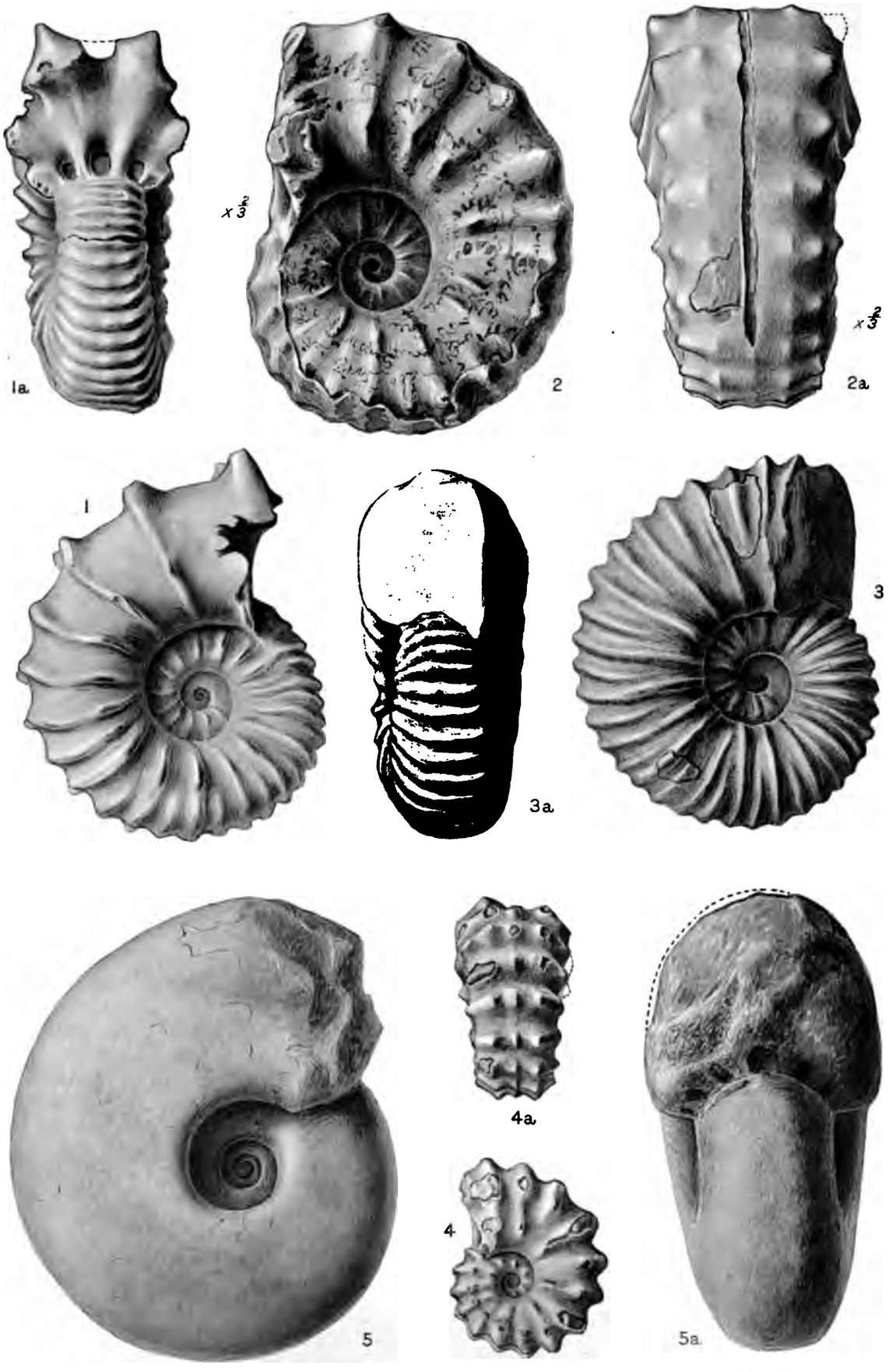

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PLATE XIII.

ACANTHOCERAS CORNIGERUM, *G. C. Crick* (p. 207).

FIG. 1.—Lateral aspect of the type-specimen.

1A.—Front view of the same example; the asymmetry of the fossil is shown at the bottom of the right-hand side of the figure.

ACANTHOCERAS QUADRATUM, *G. C. Crick* (p. 192).

2.—Lateral aspect of the type-specimen; it is completely septate, and there are traces of the dorsal portions of the septa in front of the anterior end of the fossil as far as the sixth rib.

2A.—Peripheral view of same; the groove in the centre of the periphery is produced by the laying open of the siphuncle.

ACANTHOCERAS PAUCINODATUM, *G. C. Crick* (p. 203).

3.—Lateral aspect of type-specimen.

3A.—Front view of same example.

ACANTHOCERAS HIPPOCASTANUM, *J. de C. Sowerby sp.* (p. 194).

4.—Lateral aspect of specimen.

4A.—Peripheral aspect of the same example.

TETRAGONITES TIMOTHEANUS, *Stol. sp.* (? *Mayor sp.*) (p. 172).

5.—Lateral aspect of much weathered septate specimen, with traces of some of the suture-lines.

5A.—Front view of the same example.

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PLATE XV.

GAUDRYCERAS PULCHRUM, *G. C. Crick* (p. 237).

FIG. 1.—Lateral aspect of type-specimen, showing varices and delicate transverse striation of test.

1A.—Front view of the same specimen.

ANISOCERAS *sp.* (p. 239).

2.—Lateral aspect, showing horizontal rounded ribs.

2A.—End view of same specimen, showing the siphuncle near the surface on the right-hand side of the figure.

DESMOCERAS *sp.* (p. 241).

3.—Lateral aspect of specimen.

3A.—Front view of the same.

GAUDRYCERAS *sp.* (p. 238).

4.—Lateral aspect of fragment.

4A.—Transverse section of same at posterior end.

HAUERICERAS *sp.* (p. 242).

5.—Lateral aspect of half an individual.

5A.—View of fractured surface of the same, somewhat diagrammatic.

NAUTILUS MANUANENSIS, *G. C. Crick* (p. 243).

6.—Lateral aspect of the type-specimen, × ½.

6A.—Front view of the same, × ½.

PUZOSIA COMPACTA, *G. C. Crick* (p. 246).

7.—Lateral aspect, showing the constrictions on the outer whorl.

7A.—Front view of the same specimen.

HYSTEROCERAS *sp.* (p. 248).

8.—Lateral aspect of fragment probably belonging to this genus.

8A.—Peripheral aspect of the same specimen, showing along the median line the feeble connection between adjacent ribs.

MORTONICERAS UMKWELANENSE, *G. C. Crick* (p. 228).

9.—Lateral aspect of specimen from the Umkwelane Hill Deposit, in error included with the collection from False Bay, × ½.

9A.—Peripheral view of inner whorls of the same specimen, × ½.

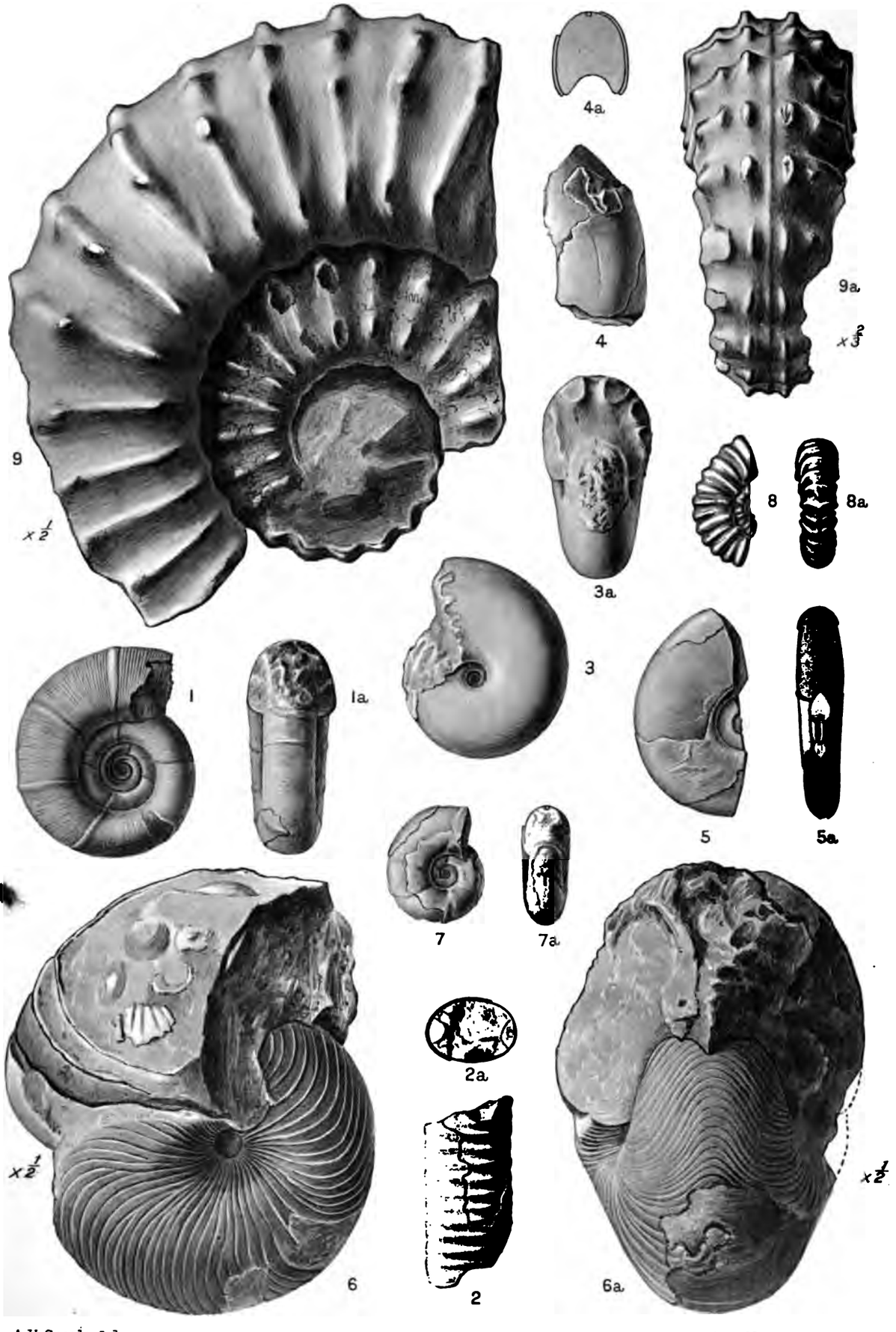

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PLATE XVI.

FIG. 1.—*Hippopotamus ponderosus*, sp. nov. Right 3rd lower molar, outer side, nat. size.

1A.—*Hippopotamus ponderosus*, sp. nov. The same tooth, crown-view.

2.—*Hippopotamus ponderosus*. Right 1st lower premolar, outer side, nat. size.

3.—*Hippopotamus ponderosus*. Right 2nd lower premolar, outer side, nat. size.

4.—*Bubalus andersoni*, sp. nov. Right lower jaw, external side; $\frac{1}{2}$ nat. size.

4A.—*Bubalus andersoni*, sp. nov. The same, crown-view; about $\frac{2}{3}$ nat. size.

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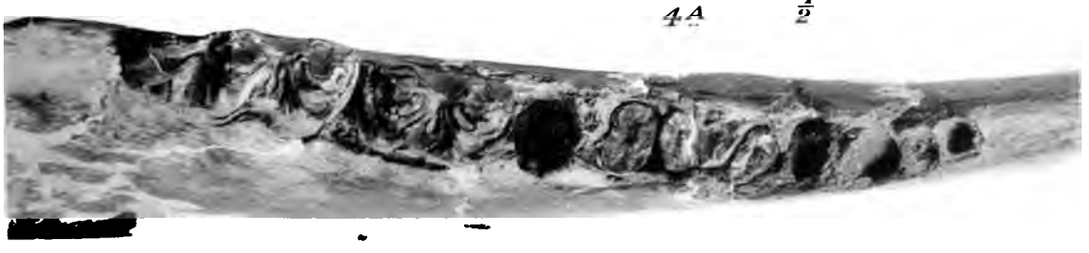

4. $\frac{3}{4}$

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PLATE XVII.

FIG. 1.—*Undetermined Antelope.* Fragment of left ramus mandibuli, with 1st and 2nd molars, nat. size.

2.—*Undetermined Antelope.* Posterior half of left 3rd lower molar, crown-view, nat. size.

3.—*Opsiceros simplicidens*, sp. nov. Left 2nd upper molar (type specimen) of young individual, unworn, crown-view, nat. size.

4.—*Opsiceros simplicidens*, ? Right 1st upper molar of old animal, crown-view, nat. size.

5.—*Opsiceros simplicidens*, ? Left 4th upper premolar, presumably of same individual as fig. 4, crown-view, nat. size.

6.—*Elephas zulu*, sp. nov. Left 3rd lower molar, inner side; slightly less than $\frac{1}{3}$ nat. size.

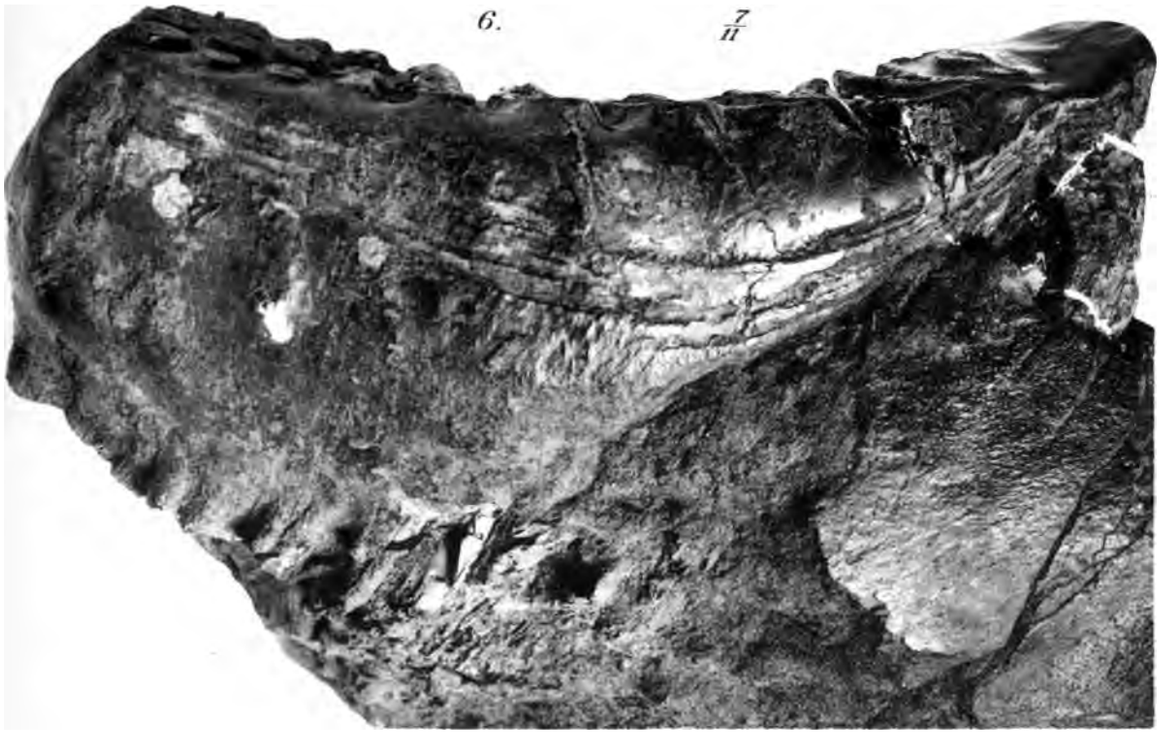

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PLATE XVIII.

FIG. 1.—*Elephas zulu*, sp. nov. Left 3rd lower molar, crown-view; slightly less than $\frac{2}{3}$ nat. size. Same tooth as Plate XVII., fig. 6.

2.—*Elephas zulu*, sp. nov. Right 3rd lower molar, crown-view; approximately $\frac{2}{3}$ nat. size. The anterior end of this tooth is broken away.

2A.—*Elephas zulu*, sp. nov. The same tooth from the inner side.

1. $\frac{5}{8}$

2. $\frac{4}{5}$

24 $\frac{4}{7}$

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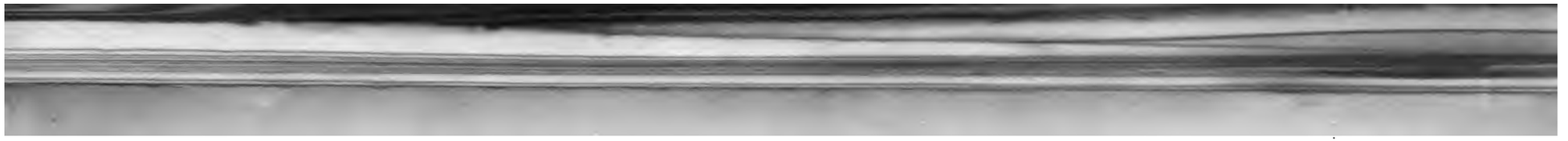

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